Chapter 4
Environmental Consequences

Contents

4.1 Introduction

The fishery management plans for the three jurisdictions considered here provide a flexible framework for managing fisheries to meet their conservation and use objectives. Each year, annual fishery plans are developed within the context of the framework plans to meet the year-specific circumstances related to the status of stocks affected by the fisheries. The federal action considered for each of the jurisdictions is NMFS' review and approval of the annual fishery plans. NMFS' review is an ongoing process that seeks to evaluate approaches taken by management agencies, within and among the three jurisdictions, to meet the underlying needs for conservation and use. In its review and consultation with these three jurisdictions, NMFS must meet its statutory obligations to protect salmonid resources; seek to maximize long-term, socioeconomic benefits (i.e., from fisheries); and meet its trust obligations to treaty Tribes. However, there are different ways to balance these objectives and different strategies that can be used that may provide better solutions for meeting the obligations and objectives of the respective fishery plans. The alternatives considered in this FPEIS are programmatic in nature and designed to provide review flexibility and an overview of fishery management methods and strategies that could be implemented as part of the annual planning process. These methods and strategies would then be subject to NMFS' review and approval. This chapter provides the analytical basis for comparing the alternatives outlined in Chapter 2.

It details the expected consequences on the physical, biological, and human environments associated with implementation of the different management measures under the proposed alternatives. Although each of the alternatives would have a different effect on the biological and human environments, effects on the physical environment in the three fishery management areas are not expected to vary among the proposed alternatives or management areas and are expected to be localized and not significant. Specific effects on the physical environments are discussed below. The biological analysis in this chapter emphasizes the effects on listed and unlisted salmon and steelhead runs. For the purposes of this analysis, these effects are defined as short-term, long-term, and cumulative.

Changes to the human environment stem from changes in management measures and the conduct of fisheries. Effects on the human environment are described first in terms of changes in season duration and then changes in structure, harvest, and fishing effort. The economic parameters used to evaluate effects on the human environment include angler benefits (i.e., net willingness to pay [WTP] for ocean salmon fishing), net income (profit) to businesses that are directly affected by angler activity, and net income to commercial fishers. Social effects are described in qualitative terms for the coastal and riverine communities of commercial and recreational fisheries affected by the federal action.

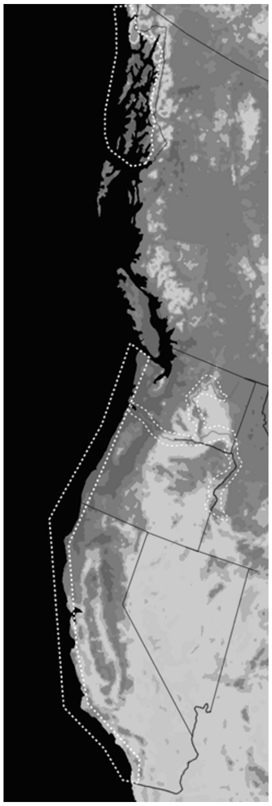
Effects on the physical environment in the three fishery management areas potentially include those caused by fishing gear on the substrate and associated benthos (e.g., attached animals and plants) and deposition of fish wastes resulting from processing activities. Fishing targets salmon in the water column and avoids any significant disturbance of the benthos, substrate, or intertidal habitat. Neither fishing nor subsequent fish processing introduces significant waste or offal into marine waters (Council 1999). As noted in Chapter 3, effects of troll and sport fishing activities on the physical environment in which the fisheries occur are basically imperceptible. Effects are not expected to vary perceptibly among alternatives.

Salmon fisheries in the Columbia River basin have little effect on the stream channel, bank, water quality, or other aspects of the physical environment. Effects on the physical environment usually result from boat launching or shoreline egress and are highest near popular fishing or access sites. Fishermen may litter or trample vegetation along streams, thus causing increased sedimentation; however, these effects are generally confined to small areas and typically do not alter the stream channel. Some ceremonial and subsistence fishermen fish from platforms in the mainstem Columbia River. Their platforms are typically erected at the same sites every year. These platforms could slightly alter current and sedimentation patterns, but the effect of these operations on the physical environment is localized and small.

Water quality conditions would not substantially change under any of the alternatives because current regulations prohibit discharge of sewage and garbage into streams. Accidental fuel spills may occur near fueling stations, but these events are rare, and the fueling stations are mainly located in areas with lower quality habitat. Spills on the fishing grounds are typically small, rare, and unpredictable events. Exhaust from fishing vessels may contribute hydrocarbons to the water, but the concentration of hydrocarbons related to fishing vessels is minimal.

4.2 Southeast Alaska

4.2.1 Effects on Biological Environment



This section presents an assessment of the biological effects for the proposed alternatives. Because Alternative 1, No Action, differs from management measures used during the baselines analyzed (1988 to 1993 and 1994 to 1997), effects under Alternative 1 are discussed relative to observed effects. Effects under Alternative 2—Reduce Chinook Nonretention Fisheries and Alternative 3—No Incidental Take are described in relation to Alternative 1. Biological effects are described in terms of the short term and long term for listed and unlisted salmon and steelhead, other fishes, listed and unlisted mammals and birds, and lower trophic-level species. Cumulative effects are also discussed in this chapter. For the purposes of this analysis, these effects are defined as follows:

1. Short-term effects: Mortalities resulting from fisheries including harvest and incidental mortality, which occurs when fishers capture and then release salmon.[1] In most cases these effects are quantified in terms of changes in harvest rate or changes in mortalities from the fisheries. Conversely, they may also be described in terms of changes in spawning escapement.
2. Long-term effects: Changes in the abundance of successive generations of the affected stock or ESU that may occur as a result of reductions in short-term effects and the consequent increase in spawning escapement. Long-term effects may also take into consideration changes in the biota due to increased escapement. In most cases these effects can only be qualitatively described although, at times, they are quantified.
3. Cumulative effects: Changes to stocks or ESUs that may result from a combination of short-term and long-term effects of the actions in the three fishery management areas plus the effects of other past, present, or foreseeable future actions.

4.2.1.1 Fisheries and Harvests

Alternative 1—No Action

As noted in Chapter 2, commercial trolling accounts for approximately 68 percent of the chinook harvest in Southeast Alaska; therefore, trolling is the primary focus in this analysis.

Effects under Alternative 1 on salmon harvests and salmon runs were calculated by applying the status quo conditions specified in Chapter 2 to two baselines—1988 to 1993 and 1994 to 1997—representing high abundance and low abundance conditions,

[1] To simplify the comparison of alternatives, this analysis considers total mortality on chinook and coho salmon, which are of legal commercial or recreational size. Effects on sub-legal salmon are discussed in the section on long-term and cumulative effects.

respectively, particularly for chinook salmon. During the period 1988 to 1993 (Baseline 1), management of the troll fishery was characterized by:

- A ceiling established by the PSC
- An unlimited winter fishery
- A spring hatchery access fishery (1989 to 1993)
- A July 1 opening date with the goal of harvesting the remainder of the allowable Pacific Salmon Commission ceiling

From 1994 to 1997 (Baseline 2) management was characterized by:

- A cap on the winter fishery
- A directed spring hatchery fishery
- A July 1 summer opening date with the goal of harvesting 70 percent of the remaining fish with the areas of high abundance opened
- The remainder of the fish being harvested later in the summer with the areas of high abundance closed

The allowable troll chinook harvest under Alternative 1 would average 282,000 for Baseline 1 and 156,000 for Baseline 2 compared to observed chinook harvests averaging 219,000 (1988 to 1993) and 155,000 (1994 to 1997). In general, this reflects that higher catch levels would be allowed under Alternative 1 than those that actually occurred during the observed years of higher relative abundance. Although not reflected in the two baselines, when abundance is relatively low, harvest would be substantially reduced from what it has been in the past.

Under Alternative 1, the harvest of coho and other species would be the same as that observed during the baselines. Between 1988 and 1997 the coho catch ranged from 500,000 to 3.5 million and averaged approximately 1.9 million coho; however, the abundance of coho does not correlate well with the abundance of chinook along the Pacific Coast and this is also true in the Southeast Alaska fishery. For analysis purposes it was assumed that the catch of coho would continue to average approximately 1.9 million coho per year.

Alternative 2—Reduce Chinook Nonretention Fisheries

Alternative 2 proposes to implement management actions designed to eliminate the need for CNR fisheries. To accomplish this the catch of chinook would have to be delayed and/or the catch rate of chinook would have to be reduced to a level that allows the troll fishery to continue to target both chinook and coho throughout the summer season. These are complex fisheries and the specific actions necessary to accomplish this objective are not known. In practice, it would probably require experimentation for managers to “learn” what actions are necessary to meet this objective. For this analysis it was assumed that the need for CNR fisheries could be largely eliminated by closing areas of high chinook abundance and delaying the start of the traditional July 1 opening date by 1 or 2 weeks depending on the relative abundance of chinook. Under Alternative 2, it is assumed that the chinook quota would be caught. CNR fishing would be allowed later in the summer season, if necessary, to continue access to harvestable coho, and thereby minimizing the potential effects on the coho fishery.

In order to comment on the effects of Alternative 2, it is necessary to characterize the expected mortality associated with the CNR fisheries (i.e., the extent to which mortality would be reduced by implementing Alternative 2). There is also uncertainty about what CNR mortality would be under Alternative 1 and how it may vary with abundance; however, the fisheries have been managed since 1994 using the current management structure. Since 1994 the estimated mortality of legal size chinook during CNR fisheries has ranged from approximately 6,000 to 22,000 and averaged 11,500. Because of the complexities of the fishery, it is difficult to predict how CNR mortality will vary with overall abundance and, thus, allowable catch. For example, there is no direct relationship between abundance and observed CNR mortalities; however, it is reasonable to expect that CNR mortality will continue to fall within the range of values observed since 1994 so long as the fishery is managed as it has been in recent years. For analytical purposes, 8,000 and 20,000 were selected from the range of observed mortality values to represent low and high estimates of expected future CNR legal mortality under Alternative 1.

To implement Alternative 2, the traditional start of the summer season opening (July 1) would likely be delayed and would result in some lost opportunity to catch coho. Associated effects on the coho catch would depend on the duration of the delay and on the catch area. Outside fisheries would likely be more affected than inside fisheries because of the availability of coho early in the season. For purposes of analysis it was assumed that the overall catch of coho would be reduced by a minimum of 5 percent and as much as 15 percent of the annual harvest.[2]

Under Alternative 2, allowable troll chinook harvest in Southeast Alaska fisheries would average 292,000 for Baseline 1 and 160,000 for Baseline 2. The average annual troll coho harvest would be approximately 1.8 million (Baseline 1) and 1.6 million (Baseline 2). Table 4.2-1 shows chinook harvest information for Alternatives 1 and 2 in the Southeast Alaska commercial troll fishery.

Table 4.2-1. Allowable chinook harvest, CNR mortality of legal-sized chinook, total mortality of legal-sized chinook, and coho harvest under theoretical applications of Alternatives 1 and 2 in the Southeast Alaska commercial troll fishery.

Alternative/ Baseline	Allowable Chinook Harvest	CNR Mortality	Total Mortality	Coho Harvest
Alternative 1 Baseline 1	282,000	20,000	302,000	1,900,000
Alternative 1 Baseline 2	156,000	8,000	164,000	1,900,000
Alternative 2 Baseline 1	292,000	None	292,000	1,805,000
Alternative 2 Baseline 2	160,000	None	160,000	1,615,000
Alternative 3	0	None	0	0

[2] In general, the summer coho fishery lasts 12 weeks, including a closure that has lasted 5 to 10 days in recent years. Catch rates of coho during the first week of the fishery are generally low, but quickly increase and remain relatively stable through much of the season. Catch rates in outside areas typically build more quickly than those in inside areas. Based on these general observations, it was assumed that a one week delay in the start of the summer season fishery would reduce coho catches by 5 to 15 percent.

Alternative 3— No Incidental Take

Coded wire tag (CWT) recoveries indicate that fish from the listed ESUs are taken in sport and commercial fisheries throughout Southeast Alaska in approximate proportion to the chinook harvest in the individual fisheries. As a result, under Alternative 3 closure of all troll and sport fisheries would be required, with the possible exception of terminal area "experimental" fisheries targeting Alaska hatchery returns. If troll fisheries in other Southeast Alaska fishing areas were also closed, it is likely that Southeast Alaska hatchery production of chinook would cease (Dave Gaudet, ADFG, personal communication).

Under Alternative 1, allowable troll chinook harvest in Southeast Alaska fisheries would average 282,000 for Baseline 1 and 156,000 for Baseline 2. The average annual observed troll coho harvest would be 1.9 million fish. Foregone harvests under Alternative 3 with respect to observed harvests would be approximately 330,000 (Baseline 1) and 143,000 (Baseline 2) for chum, 842,000 (Baseline 1) and 753,000 (Baseline 2) for pink, and 16,000 (Baseline 1) and 25,000 (Baseline 2) for sockeye. Foregone marine sport harvests of all salmon species would average more than 217,000 fish for Baseline 1 and 292,000 for Baseline 2. The foregone sport harvest of chinook salmon would average 44,000 and 51,000 fish, and foregone coho harvests would average 98,000 and 155,000 for Baselines 1 and 2, respectively.

4.2.1.2 Salmon Harvest

Short-term effects (i.e., mortalities resulting from fisheries) on adult chinook salmon under Alternatives 1 and 2 include harvest and incidental mortality. The incidental mortality of legal-sized chinook in the troll fishery is presumably eliminated under Alternative 2. Short-term effects on other salmon species include harvest. As described in the previous section, harvest of pink, chum, and sockeye salmon in the troll fishery would remain the same under Alternatives 1 and 2. It was assumed that average coho catches under Alternative 2 would be reduced by 5 percent (95,000) or 15 percent (285,000) depending on the required delay in the July 1 opening.

Apart from the hatchery stocks that are targeted in terminal-area fisheries, more than 96 percent of the Southeast Alaska chinook harvest originates from four stock groups (PSC 1997):

- British Columbia (average 59 percent)
- Columbia Upriver/Mid-river Bright (20 percent)
- Oregon and Washington Coastal (8 and 5 percent, respectively)
- Southeast Alaska (4 percent)

Puget Sound, Snake River Fall-run, Lower Columbia River, and Upper Willamette River ESUs represent less than 3 percent of the harvest combined. These percentages include both listed fish and the unlisted hatchery components from these ESUs. The remaining 1 percent of the Southeast Alaska chinook catch is, on average, the Columbia River summer stock, which are not listed. Nearly all coho salmon harvested in Southeast Alaska originate from Alaskan streams (Weitkamp et al. 1995). The proposed delayed start date under Alternative 2 is not expected to affect the stock composition of the harvest compared to Alternative 1. Few steelhead are taken in Southeast Alaska troll or marine sport fisheries.

Alternative 1—No Action

For the fishery modeled under Alternative 1, the approximate incidental mortality of legal-sized chinook released in the CNR troll fishery ranged from 20,000 (Baseline 1) to 8,000 (Baseline 2); however, it is not necessarily true that higher CNR mortality will be associated with higher abundance. Total fishing mortality (harvest equals incidental mortality of legal-sized chinook) would be 302,000 and 164,000 for Baselines 1 and 2, respectively. Additional sub-legal mortalities (i.e., mortalities resulting from the release of undersized chinook that occurred regardless of whether chinook retention is allowed) in the range of 34,000 to 97,000 annually would also be expected, although many of these immature fish will not recruit to the fishery or subsequent escapement because of intervening natural mortality. In recent years, sub-legal mortalities have typically been at the low end of the range.

Alternative 2—Reduce Chinook Nonretention Fisheries

Under Alternative 1, the allowable chinook harvest for Baselines 1 and 2 are 282,000 and 156,000, respectively (Table 4.2-1). Based on observations from recent years, eliminating the CNR fishery would likely reduce the incidental mortality of legal-sized chinook by 8,000 to 20,000 fish. The Pacific Salmon Treaty does provide an incentive to encourage actions to reduce CNR mortality by providing that half the adult equivalent mortality savings be added to the allowable catch; therefore, the actual mortality reductions under Alternative 2 would range from approximately 4,000 to 10,000 fish annually. Allowable chinook catches would be 292,000 and 160,000 for Baselines 1 and 2, respectively (Table 4.2-1).[3] For a given size limit, incidental mortality of sub-legal chinook is generally driven by stock and brook relative abundance and would be reduced from Alternative 1 in proportion to the number of days the fishery was closed.

Alternative 3—No Incidental Take

Compared to the No Action Alternative, Alternative 3 would result in increased escapements of salmon (particularly coho) from the ocean to inside waters. This increased escapement could result in increased harvests in net fisheries and in inside troll fisheries. Estimating changes in these harvests is beyond the scope of this analysis. Because chinook, coho, sockeye, pink, and chum salmon in Southeast Alaska have been at historically high levels in the 1980s and 1990s, it is unlikely that increased escapements would have any significant benefit for Alaska stocks. In fact, there could be a negative effect on some populations (particularly coho) from over escapement.

There could be benefits from Alternative 3 relative to the No Action Alternative in terms of increased spawning escapement to British Columbia streams, especially for those runs classified as of special concern or at risk of extinction that are affected by the Southeast Alaska fishery. Escapement to these streams depends largely on fishing patterns of the

[3] The actual transfer of mortality reductions to the catch ceiling would be diminished somewhat to account for adult equivalence calculations; however, in order to keep the presentation as simple as possible, NMFS have assumed that half the mortality reductions would be transferred to allowable catch.

British Columbia sport and commercial fleet, which are determined, in part, by the Pacific Salmon Treaty. In recent years fisheries in British Columbia have been constrained well beyond requirements from the Pacific Salmon Treaty because of domestic conservation concerns. A closure of the Alaskan fishery would benefit Canadian stocks to the degree that the unharvested fish were allowed to pass through subsequent fisheries to escapement. It is not known how Canada would respond to Alternative 3.

Closing troll and sport fisheries in Southeast Alaska would increase recruitment of upper Columbia River fall, Washington Coastal, and Oregon Coastal chinook stocks to the Council management area. Again, accrual of these escapements to the spawning grounds depends on subsequent management actions in British Columbia and Pacific Coast fisheries (see Section 4.5, Cumulative Effects).

4.2.1.3 Listed Salmon

Alternative 1—No Action

Listed salmon taken in the Southeast Alaska fishery include Snake River fall chinook, Willamette River spring chinook, Lower Columbia River chinook, and Puget Sound chinook. In describing the effects to listed fish, this analysis discusses the general effects to each of the ESUs, and then as an example, focuses on Snake River fall chinook in more detail. Estimates of exploitation rates and numerical effects to listed fish are derived from the Pacific Salmon Treaty Chinook Technical Committee (CTC) model (a description of the structure of the CTC chinook model is provided in Appendix F). The CTC model calibration 0021 was used to provide estimates of observed effects. The average allowable catch under Alternative 1 for Baseline 1 would be approximately 29 percent higher (282,000 vs. 219,000) than the observed catch. The observed catch for Baseline 2 was approximately the same as the expected average catch under Alternative 1 (156,000).

The total adult equivalent exploitation rates for all fisheries combined for Snake River fall chinook for Baselines 1 and 2 were 71.8 percent and 45.1 percent, respectively (Table 4.2-2). The average observed exploitation rates in the Southeast Alaska fishery were 4.3 percent (Baseline 1) and 4.6 percent (Baseline 2) and accounted for 4.7 percent and 10.2 percent of the total harvest effects for Baselines 1 and 2, respectively. The exploitation rate under Alternative 1 for Baseline 1 would be 29 percent greater than that observed or approximately 4.3 percent. The estimated average number of listed Snake River fall adult equivalent chinook killed would be 145 and 101 for Baselines 1 and 2, respectively.[4] Under Alternative 1 the actually adult equivalent mortality during Baseline 1 would be approximately 187 fish (145 x 1.29 = 187) after accounting for the difference between the observed fisheries and those expected to occur under status quo management (i.e., Alternative 1).

[4] Estimates of numerical impacts to listed fish are problematic because they generally depend on a series of underlying assumptions. Different methods will generally lead to different results. Estimates of numerical impacts are provided here, but are best used along with the exploitation rate estimates to provide a relative sense of impact and for comparing the relative effect of different alternatives within this document. They should not be compared directly with similar estimates derived from other sources without adequate consideration of potential inconsistencies resulting from the underlying methods.

Table 4.2-2. The observed adult equivalent exploitation rate for all fisheries combined, and the expected exploitation rate for the Southeast Alaska fishery under Alternatives 1 and 2.

		Exploitation Rate	Southeast Alaska Exploitation Rate		
ESU (stock)	**Baseline**	**(All Fisheries)**	**Alternative 1**	**Alternative 2**	**Alternative 3**
Snake River Fall	1	71.8	4.3	4.2	0
	2	45.1	4.6	4.5	0
Upper Willamette River	1	42.7	5.3	5.2	0
	2	35.5	4.8	4.7	0
Lower Columbia River (brights)	1	53.7	9.5	9.3	0
	2	31.1	8.5	8.3	0
Puget Sound	1	73.6	0.4	0.4	0
	2	59.7	0.4	0.4	0

Observed adult equivalent exploitation rates for Upper Willamette River spring chinook in the Alaskan fisheries were 4.1 percent and 4.8 percent for Baselines 1 and 2, respectively. The expected adult equivalent exploitation rate under Baseline 1 would be 5.3 percent.

The bright stocks are the component of the Lower Columbia River ESU that is subject to the greatest harvest in the Alaskan fishery. Observed exploitation rates for the Lower Columbia River bright stocks were 7.4 percent (Baseline 1) and 8.5 percent (Baseline 2). The expected adult equivalent exploitation rate under Baseline 1would be 9.5 percent.

Effects to Puget Sound stocks in the Alaskan fishery are generally quite low. Observed exploitation rates for all Puget Sound stocks combined averaged 0.3 percent (range of 0.0 to 4.9 percent) for Baseline 1 and 0.4 percent (range of 0.0 to 5.4 percent) for Baseline 2. The expected adult equivalent exploitation rate under Baseline 1 would be 0.4 percent.

Alternative 2—Reduce Chinook Nonretention Fisheries

Compared to the No Action Alternative, the overall mortality would be reduced by 2.6 percent for Baseline 1 and 1.8 percent for Baseline 2 under Alternative 2 (Table 4.2-2). The magnitude of reduction in effects to listed fish would be similar. For example, the exploitation rate under Alternative 1 for Baseline 1 would be reduced by 2.6 percent from 4.3 percent to approximately 4.2 percent. The numerical effect to listed Snake River fall chinook would be reduced from 187 to 182 for Baseline 1 and from 101 to 99 for Baseline 2.

Alternative 3— No Incidental Take

Foregoing all AABM harvest in Southeast Alaska fisheries that is allowed under Alternatives 1 and 2 would eliminate nearly all harvest to the listed species. The size of the resulting reduction in the total exploitation rate depends on the ESU. For Snake River fall chinook, the overall exploitation rate would be reduced by 5 or 10 percent depending on the baseline used. Total mortality to Snake River fall chinook, for example, would be reduced by an estimated 187 adults for Baseline 1 and 101 adults for Baseline 2. The harvest reductions for other listed chinook would be similar depending on their ocean distribution relative to the major ocean and freshwater fisheries.

4.2.1.4 Non-Salmonid Fish Species

Alternative 1—No Action, Alternative 2—Reduce Chinook Nonretention Fisheries, and Alternative 3—No Incidental Take

Incidental harvest of non-salmon fish species in the direct salmon fishery are not monitored or quantified because the widely held assumption is that no population level effects exist (NMFS 1997a). Because Alternative 2 proposes only slight modifications in fishing seasons, effects of fishing activities (as they relate to interactions with other fish species) would be essentially the same as under Alternative 1. Incidental harvest on non-salmon fish species is believed to be minimal under either Alternative 1 or 2. Under Alternative 3, these minimal effects would be eliminated. Additional effects under Alternative 3 would include a decrease in fishery-related interactions; localized, short-term increases in availability of salmon to predators; and an increase in predation on salmon prey species caused by the decline in harvest. Closure of the ocean sport fishery for salmon under Alternative 3 could result in increased fishing pressure on bottomfish fully allocated to fisheries, and increases in sport effort and harvest could result in management problems and conservation concerns for these species.

4.2.1.5 Listed and Unlisted Mammalian Species

Alternative 1—No Action, Alternative 2—Reduce Chinook Nonretention Fisheries, and Alternative 3—No Incidental Take

Interactions between marine mammal species and the salmon fishery occur when fishing vessels approach marine mammals, marine mammals prey on hooked salmon, and marine mammals become snagged or entangled in fishing gear, which is very rare. Troll fisheries in Southeast Alaska are classified under the Marine Mammal Protection Act as Class III fisheries with little or no suspected effect. Limited data preclude a definitive analysis of the effect fish and marine mammal removals have on other populations within the ecosystem (NMFS 1997a). Because Alternative 2 proposes only slight modifications in fishing seasons, effects of fishing activities relative to Alternative 1 (as they relate to interactions with mammalian species) would be essentially nonexistent. Effects under Alternative 3 would include a decrease in fishery-related interactions; localized, short-term increases in availability of salmon to predators; and an increase in predation on salmon prey species caused by the decline in harvest.

4.2.1.6 Listed and Unlisted Avian Species

Alternative 1—No Action, Alternative 2—Reduce Chinook Nonretention Fisheries, and Alternative 3—No Incidental Take

Effects of fishing activity on seabirds occur through direct mortality from collisions with vessels and entanglement with fishing gear. Indirect impacts include competition with the commercial fishery for prey, alteration of the foodweb dynamics due to commercial fishery removals, disruption of avian feeding habits resulting from developed dependence on fishery waste, fish-waste related increases in gull populations that prey on other bird species, and marine pollution and changes in water quality. Competition between seabirds and fisheries for forage fish is difficult to evaluate. Climatic fluctuations undoubtedly contribute to fluctuations in seabird food resources (Wooster 1993), but so may fisheries (Duffy 1983, Steele 1991).

Fish processing provides food directly to scavenging species such as Northern Fulmars and large gulls. This can benefit populations of some species but it can be detrimental to others, which may be displace or preyed upon (Furness and Ainley 1984). Predation by birds has effects on fish populations, which have variously been estimated as minor to significant (reviewed by Croxall 1987).

Seabirds are caught in many types of fishing gear but troll gear is not known to harvest birds, and salmon troll fishing is not known to provide significant waste and offal to attract scavenging birds. Because Alternative 2 proposes only slight modifications in fishing seasons, effects of fishing activities relative to Alternative 1 (as they relate to interactions with avian species) would be essentially nonexistent. Effects under Alternative 3 would include a decrease in fishery-related interactions; localized, short-term increases in availability of salmon to predators; and an increase in predation on salmon prey species caused by the decline in harvest.

4.2.1.7 Lower Trophic Level Species

Alternative 1—No Action, Alternative 2—Reduce Chinook Nonretention Fisheries, and Alternative 3—No Incidental Take

Fishing gear used in the salmon fishery has minimal, if any, effect on lower trophic level species. The activity targets only adult salmon in the water column and avoids any significant disturbance of benthos, substrate, or intertidal habitat (NMFS 1997a).

Marine ecosystems in the north Pacific Ocean are complex webs of predator/prey relationships. Because the status of each component stock may change annually, predator/prey relationships are also expected to vary. All harvest removes animals that otherwise would have remained in the ecosystem where they would have preyed on other animals and/or would be preyed upon. The abundance-based chinook stocks assessment process includes adjusting for natural mortality and predation although the algorithm is limited by an incomplete understanding of the dynamic parameters for growth, recruitment, and mortality (NMFS 1997a).

Because Alternative 2 proposes only slight modifications in fishing seasons relative to Alternative 1, change in fishing activities as they relate to interactions with lower trophic level species would be essentially nonexistent. The effect of Alternative 3, closing troll and sport salmon fisheries, on the overall food web, salmon escapements, and marine and freshwater biota is difficult to assess, particularly because of the interactions with fisheries outside of the action area (i.e., inside fisheries.)

4.2.2 Effects on the Human Environment

4.2.2.1 Introduction

This section presents an assessment of the economic and social effects for the proposed alternatives. Economic effects, including social welfare and regional economic effects, are described separately for each of the alternatives, followed by a more general discussion of the implications of these effects for the commercial and recreational fishing communities, the port communities, and surrounding boroughs. Under each alternative, effects are described for higher chinook abundance conditions from 1988 to 1993 (Baseline 1) and for lower chinook abundance conditions from 1994 to 1997 (Baseline 2).

The economic and social effects analyses are based on results from the fishery model described in the previous section. For the economic effects analysis, the two key outputs of the fishery model are harvest for commercial fishermen and angler effort. When reviewing the results of the economic analysis it is important to remember that, even in the case of Alternative1—No Action, commercial harvest is estimated through fishery modeling procedures and differs from observed historical values. Model-generated values are compared to observed historical values, where appropriate, to provide a context for their interpretation.

4.2.2.2 Analytical Methods

Ideally, the economic analysis would evaluate differential effects of the proposed alternatives over time, including an assessment of the effects on stock rebuilding and the potential benefits of easing harvest restrictions associated with species listings. This type of analysis also would consider the opportunity costs associated with using resources to harvest the available stocks, and all economic effects would be evaluated "at the margin." Because of limited data and that many factors other than harvest management affect stock re-building, this type of dynamic analysis was not possible for this FPEIS. Alternatively, this assessment focuses on potential effects on commercial and recreational fisheries associated with short-term changes in harvest practices. Average conditions during periods of both higher and lower abundance (Baselines 1 and 2, respectively) are considered to capture some of the variability inherent in this type of "static" analysis. Potential economic and social benefits associated with moving toward recovery over the long term are discussed in Section 4.5, Cumulative Effects.

The discussions of economic effects associated with ocean sport fishing and commercial troll fishing for salmon under each alternative are separated into effects on the sum of net economic benefits produced by the national economy (i.e., social welfare effects) and effects on the distribution of net benefits among identifiable components of society. When reviewing these effects it is important to note the following:

Alternative 1—No Action

Because Alternative 1 serves as the baseline for the alternatives analysis, economic effects are described but are not compared to other baseline conditions or alternatives. Changes in economic effects from implementing the alternatives compared to Alternative 1 are described in subsequent sections.

Alternative 2—Reduce Chinook Nonretention Fisheries

Under Alternative 2, there could be adjustments in the duration and timing of the main summer commercial troll season, as well as potential closures of high chinook abundance and gear restrictions to dampen chinook catch rates. This chapter presents the assessment of economic effects for Alternative 2, which is a mixed-stock retention fishery alternative. In addition to the economic effects described in this chapter, measures to control chinook catch rates, such as gear restrictions, could increase harvest costs for the commercial fishing industry by increasing the level of effort required per pound of harvested salmon. These costs are not expected to be substantial but could add to the adverse economic effects associated with reduced net income to commercial fishers under Alternative 2.

Alternative 3—No Incidental Take

Under Alternative 3, both troll salmon and recreational salmon fisheries would be closed. In addition to the effects on ocean sport and commercial troll fishing for salmon described below, Alternative 3 would likely increase opportunities and associated economics of sport fishing for salmon in inland waters, especially for coho salmon. Opportunities for catching some of these fish in commercial net fisheries also are likely; however, because of the high level of uncertainty of these effects, they are not quantified in this analysis.

One kind of distributional effect is estimated by a regional economic effects analysis. This approach is used to estimate the expected changes in economic activity within a specific geographic region resulting from the adoption of specific alternatives. The region is specified to cover the area where changes are expected to be concentrated.

For the purposes of this analysis, the economic parameter used to evaluate the social welfare effects of changes in ocean sport fishing for salmon is angler benefits (i.e., net WTP for ocean salmon fishing). For commercial troll fishing for salmon, the parameter used to evaluate social welfare effects is the net income (profit) to commercial troll fishers associated with changes in the ex-vessel value of the salmon harvested, including chinook, coho, sockeye, chum, and pink salmon. This net income, or profit, approximates producer surplus and nets out operating costs, which are measured by the opportunity costs of resources being diverted into the fish production process. As discussed in Appendix D, changes in the commercial harvest of salmon are also expected to have consumer surplus effects but these effects could not be reliably quantified for this analysis. The parameters used to measure distributional effects from changes in ocean sport and troll fishing for salmon are the direct personal income contribution to the commercial fishing industry and to businesses that sell goods and services to sport anglers within specific boroughs, and changes in net income to businesses that are directly affected by angler activity.

The details of the methodology employed to estimate economic effects within the Southeast Alaska study area are described in Appendix D. The following sections summarize this methodology.

Social Welfare Effects

Ocean Sport Fishing for Salmon

For each baseline (1988 through 1993 and 1994 through 1997), the average annual number of sport fishing trips in Southeast Alaska was estimated using ADF&G observed data. This information was used to quantify salmon angler days made by residents and nonresidents, sport fishing-related expenditures by anglers, net income to sport fishing-related businesses from salmon fishing, and net benefits to ocean salmon anglers. The number of fishing trips was converted to angler days using a multiplier of 1.53, which was derived from ADF&G data for Southeast Alaska for 1996. Angler days were then allocated between resident anglers (52.3 percent) and nonresident anglers (47.7 percent) based on ADF&G data. The proportion of angler days targeted on salmon (58 percent for residents and 48 percent for nonresidents) was estimated based on data in a report by Jones & Stokes Associates (1991). The number of resident and nonresident salmon angler days was then allocated to communities in Southeast Alaska based on each community's relative proportion of population in the harvest area.

The net benefits to ocean salmon anglers, as measured by their net WTP for salmon fishing opportunities, were estimated based on average per trip values for sport fishing for salmon by harvest area, as reported by Jones & Stokes Associates (1991). Refer to Appendix D for a list of these values, which ranged from $29 to $187 for resident anglers and from $88 to $203 for nonresident anglers.

Commercial Troll Fishing for Salmon

The chinook and coho salmon harvest was estimated by alternative for different areas of Southeast Alaska. These estimates were derived using a spreadsheet model that allocates the allowable annual quota of chinook harvest to commercial troll fishers based on observed weekly harvests during the two baselines (1988 through 1993 [Baseline 1] and 1994 through 1997 [Baseline 2]). The length of the season, which is the primary variable that affects harvest, was specified consistent with the objectives of the alternatives discussed in Chapter 2. Harvest estimates of other salmon reflect the average annual harvest observed for Baselines 1 and 2. This information was used to estimate ex-vessel value (revenues) and net income (profits) to commercial salmon fishers by port area.

To estimate ex-vessel value, harvest estimates were allocated to the port areas of Southeast Alaska based on information on fish ticket receipts from 1995 to 1998. Ex-vessel values of landings by port were then estimated based on the average value per fish in 1997. Net income to permit holders trolling for salmon was estimated based on a net income coefficient (0.426) derived from *Economic effects of management changes for Kenai River late-run sockeye* (Institute of Social and Economic Research 1996) (refer to Appendix D for a comparison of net income coefficients employed by other fishery economic studies). As indicated above, changes in consumer surplus could not be quantified for this analysis but are discussed in Appendix D.

Distributional Effects

Ocean Sport Fishing for Salmon

Direct personal income generated by salmon angler spending was estimated based on resident and nonresident personal income coefficients derived from the *Southeast Alaska sport fishing economic study* (Jones & Stokes Associates 1991). The resulting coefficients (0.38 for resident and 0.47 for nonresident spending) were applied to total estimated business revenues generated by ocean salmon sport fishing (using the methodology discussed above) to arrive at an estimate of direct personal income for each alternative. The analytical procedures used to estimate direct personal income effects do not differentiate between spending by resident and nonresident anglers. From a local or regional economic effect perspective, this distinction is important because spending by anglers who live outside the region of interest represents "new" income to the region, whereas spending by residents of the region is primarily income that is re-directed from other activities in the region. This distinction could not be accurately accounted for in the analysis because of limited data on spending patterns of resident anglers. The effect on the analysis of not accounting for this is that the estimates of changes in direct personal income are overstated, probably by 20 percent to 30 percent.

Per-day expenditures by residents and nonresidents on sport fishing for salmon at different marine locations throughout Southeast Alaska were estimated based on weighted spending profiles developed by Jones & Stokes Associates (1991). The per-day spending profiles were multiplied by the estimated salmon angler days to estimate total revenues received by sport fishing-related businesses. The net income received by affected sport fishing-related businesses was estimated based on a net income coefficient of 0.116, which was derived from data on proprietary income in the 1992 IMPLAN database. This coefficient was then applied to sport fishing-related revenues to estimate net income for affected businesses (refer to Appendix D for more discussion of how the net income coefficient was derived).

Commercial Troll Fishing for Salmon

The direct personal income (earnings and profits) to commercial fishers (permit holders and crew) trolling for salmon was estimated based on a direct income coefficient derived from ADF&G's *Economic analysis of the seafood industry in Southeast Alaska: importance, personal income and employment* 1994 (1999b). This coefficient (0.477) was applied to estimated ex-vessel revenue (methodology discussed previously) to arrive at an estimate of direct personal income for each alternative.

The income effects on processors are not included in the analysis of local income effects. Based on the income relationship between harvesters and processors reported by Hartman (1999), the direct income effects to processors could be approximated at 36 percent of the effects on harvesters.

4.2.2.3 Social Welfare Effects

Ocean Sport Fishing for Salmon

Alternative 1—No-Action

The analysis of ocean sport fishing for salmon focuses on social welfare effects associated with predicted angler trips. The economic parameters used to evaluate these effects include angler benefits (i.e., net WTP for ocean salmon fishing) and net income (profit) to businesses that are directly affected by angler activity. The types of businesses that would be affected include charter boat and marina operations, lodging, food and beverage establishments, food stores, service stations, and other miscellaneous retail businesses.

The number of predicted angler trips for salmon, including private and charter boat trips, under Alternative 1, Baseline 1 is shown in Table 4.2-3. As shown, total salmon angler days regionwide are estimated at 217,700, with resident anglers accounting for approximately 123,100 angler days, or 56 percent of all angler days, and nonresident anglers accounting for approximately 94,600 angler days, or 44 percent of angler days. Juneau accounts for approximately 74,100 salmon angler days and approximately $16.4 million in angler benefits, or 34 and 38 percent, respectively, of regionwide totals.

The next most affected communities are Ketchikan and Sitka, accounting for 22 and 16 percent, respectively, of regionwide salmon angler benefits.

As shown in Table 4.2-3, predicted angler trips and angler benefits would increase regionwide for Baseline 2 compared to Baseline 1. This is because coho abundance was higher during the years in which Baseline 2 is based (1988 to 1993). Some communities, however, would experience a decrease in benefits. Communities where effort and angler benefits would decrease (relative to Baseline 2) include Ketchikan, Metlakatla, Petersburg, Kake, Wrangell, Haines, and Yakutat. Regionwide, the number of salmon angler days is predicted to increase by approximately 20,400 trips (9 percent) compared to Baseline 1. Angler benefits would increase by $12.5 million (30 percent).

Alternative 2—Reduce Chinook Nonretention Fisheries

Under Alternative 2, ocean sport fishing for salmon would not be affected; salmon angler days and angler benefits would remain the same as under Alternative 1.

Alternative 3—No Incidental Take

Under Alternative 3, there would be no sport fishing for salmon in coastal waters. The effect of this alternative would be to forego the social welfare effects of ocean sport fishing for salmon generated by Alternative 1, which are shown in Table 4.2-3. Under Alternative 3 anglers would forego the benefits associated with ocean sport fishing for salmon under Alternative 1, which are estimated regionwide to be $42.1 million based on 217,700 salmon angler days for Baseline 1 (Table 4.2-3). Resident anglers would forego approximately $24.3 million in benefits and nonresident anglers would forego approximately $17.7 million in benefits. Sport fishing for salmon in inland waters or fishing for marine species other than salmon would likely to recapture some of the foregone angler benefits.

For Baseline 2, anglers would forego $54.5 million in angler benefits, with resident anglers foregoing approximately $31.2 million and nonresident anglers foregoing approximately $23.4 million in annual benefits (Table 4.2-3). As indicated above, some of the foregone angler benefits are likely to be recaptured by sport fishing for salmon in inland waters or by sport fishing for marine species other than salmon.

Commercial Troll Fishing for Salmon

Alternative 1—No Action

The analysis of commercial troll fishing for salmon focuses on social welfare effects associated with the ex-vessel value of the salmon harvest including chinook, coho, sockeye, chum, and pink salmon. The economic parameter used to evaluate these effects is the net income (profit) to commercial troll fishers.

The ex-vessel value and net income to commercial fishers from troll-caught salmon under Alternative 1 are shown in Table 4.2-4 for Baseline 1. As shown, the ex-vessel values for troll-caught salmon at all ports in Southeast Alaska is approximately $26.7 million and the net income to commercial salmon fishers is approximately $11.4 million. Almost half (47 percent) of the total landings and net income would occur in Sitka. The next most important ports are Excursion Inlet, Hoonah, and Ketchikan.

Table 4.2-3. Net economic values for sport fishing in Southeast Alaska under Alternative 1 for Baselines 1 and 2.

Community (Sport Fishing Area)	Baseline 1			Baseline 2		
	Salmon Angler Days	Angler Benefits	Net Income to Businesses	Salmon Angler Days	Angler Benefits	Net Income to Businesses
Ketchikan (Area A)	37,871	$9,303,479	$544,839	36,357	$8,325,753	$523,054
Resident anglers	21,691	$4,967,239	$117,530	20,824	$4,768,696	$112,832
Nonresident anglers	16,180	$4,336,240	$427,309	15,533	$3,557,057	$410,222
Metlakatla (Area A)	6,137	$1,517,303	$93,498	5,892	$1,349,268	$89,756
Resident anglers	3,267	$748,143	$17,702	3,137	$718,373	$16,997
Nonresident anglers	2,870	$769,160	$75,796	2,755	$630,895	$72,759
Craig (Area B)	17,491	$2,048,992	$251,641	25,080	$5,743,320	$360,815
Resident anglers	10,018	$1,182,124	$54,281	14,365	$3,289,585	$77,835
Nonresident anglers	7,473	$866,868	$197,360	10,715	$2,453,735	$282,980
Petersburg (Area C)	13,515	$1,259,462	$194,916	12,452	$2,851,508	$179,144
Resident anglers	7,718	$285,566	$41,819	7,132	$1,633,228	$38,644
Nonresident anglers	5,797	$973,896	$153,097	5,320	$1,218,280	$140,500
Kake (Area C)	3,105	$288,722	$44,680	2,869	$657,001	$41,280
Resident anglers	1,778	$65,786	$9,634	1,643	$376,247	$8,902
Nonresident anglers	1,327	$222,936	$35,046	1,226	$280,754	$32,378
Wrangell (Area C)	10,267	$954,445	$147,698	9,487	$2,172,523	$136,482
Resident anglers	5,881	$217,597	$31,865	5,434	$1,244,386	$29,443
Nonresident anglers	4,386	$736,848	$115,833	4,053	$928,137	$107,039
Sitka (Area D)	33,813	$6,890,863	$486,452	45,000	$10,305,000	$787,059
Resident anglers	19,367	$4,435,043	$104,937	25,774	$5,902,246	$647,406
Nonresident anglers	14,446	$2,455,820	$381,515	19,226	$4,402,754	$139,653
Hoonah (Area D)	3,451	$703,313	$49,640	4,593	$1,051,797	$66,072
Resident anglers	1,977	$452,733	$10,712	2,631	$602,499	$14,256
Nonresident anglers	1,474	$250,580	$38,928	1,962	$449,298	$51,816
Pelican (Area D)	574	$116,991	$8,253	763	$174,727	$10,978
Resident anglers	329	$75,341	$1,783	437	$100,073	$2,368
Nonresident anglers	245	$41,650	$6,470	326	$74,654	$8,610
Elfin Cove (Area D)	192	$39,130	$2,762	256	$58,624	$3,675
Resident anglers	110	$25,190	$596	147	$33,663	$796
Nonresident anglers	82	$13,940	$2,166	109	$24,961	$2,879
Juneau (Area E)	74,077	$16,355,651	$1,065,731	76,765	$17,579,185	$1,104,394
Resident anglers	42,428	$10,437,288	$229,890	43,968	$10,068,672	$238,234
Nonresident anglers	31,649	$5,918,363	$835,841	32,797	$7,510,513	$866,160
Haines (Area F)	5,834	$815,319	$83,942	4,711	$1,078,819	$67,782
Resident anglers	3,341	$511,173	$18,103	2,698	$617,842	$14,619
Nonresident anglers	2,493	$304,146	$65,839	2,013	$460,977	$53,163
Excursion Inlet (Area G)	1,409	$253,288	$20,272	2,156	$493,724	$31,015
Resident anglers	807	$158,172	$4,373	1,235	$282,815	$6,692
Nonresident anglers	602	$95,116	$15,899	921	$210,909	$24,323
Gustavus (Area G)	5,182	$931,540	$74,553	7,934	$1,816,886	$114,150
Resident anglers	2,968	$581,728	$16,082	4,544	$1,040,576	$24,621
Nonresident anglers	2,214	$349,812	$58,471	3,390	$776,310	$89,529
Yakutat (Area H)	4,780	$574,249	$97,333	3,792	$868,368	$54,553
Resident anglers	1,377	$162,486	$7,461	2,172	$497,388	$11,769
Nonresident anglers	3,403	$411,763	$89,872	1,620	$370,980	$42,784
REGION TOTAL	**217,698**	**$42,052,747**	**$3,166,210**	**238,107**	**$54,526,503**	**$3,570,209**
Resident anglers	**123,057**	**$24,305,609**	**$666,768**	**136,141**	**$31,176,289**	**$1,245,414**
Nonresident anglers	**94,641**	**$17,747,138**	**$2,499,442**	**101,966**	**$23,350,214**	**$2,324,795**

Notes:
Angler benefits are estimated based on average values per salmon trip for each sport fishing area, as reported by Jones & Stokes Associates (1991).
Net income to businesses is estimated at 11.6 percent of angler spending and was derived from information on proprietary income from IMPLAN for coastal counties in Oregon and California. A weighted (based on proportionate spending) average from the following sectors was used: food stores, food and beverage establishments, service stations and fuel, lodging, and miscellaneous retail trade.
All monetary values are in constant 1996 dollars.

Table 4.2-4. Net income to commercial salmon fishers in Southeast Alaska under Alternatives 1 and 2 for Baseline 1.

	Alternative 1		Intermediate (Mixed Stock Fishery) Alternative			
				Net Income to Commercial Fishers		
Area/Community	Ex-Vessel Value	Net Income to Commercial Fishers	Ex-Vessel Value	Value	Alternative 2	Reduced Chinook Non-retention
Area A – Ketchikan						
Ketchikan	$1,986,692	$846,331	$1,946,921	$829,388	($16,942)	(2.0)
Metlakatla	$34,682	$14,775	$33,992	$14,481	($294)	(2.0)
Area B – Prince of Wales						
Craig	$1,042,676	$444,180	$1,021,805	$435,289	($8,891)	(2.0)
Area C - Kake/Petersburg						
Petersburg	$1,883,090	$802,196	$1,847,603	$787,079	($15,117)	(1.9)
Kake	$538,659	$229,469	$527,874	$224,874	($4,594)	(2.0)
Wrangell	$234,679	$99,973	$229,981	$97,972	($2,001)	(2.0)
Area D – Sitka						
Sitka	$12,594,854	$5,365,408	$12,342,697	$5,257,989	($107,419)	(2.0)
Hoonah	$2,088,039	$889,505	$2,046,240	$871,698	($17,806)	(2.0)
Pelican	$1,346,539	$573,626	$1,319,582	$562,142	($11,484)	(2.0)
Elfin Cove	$437,344	$186,309	$428,588	$182,578	($3,730)	(2.0)
Area F – Juneau						
Juneau	$437,344	$186,309	$428,588	$182,578	($3,730)	(2.0)
Area F – Haines/Skagway						
Haines	$34,682	$14,775	$33,992	$14,481	($294)	(2.0)
Area G - Glacier Bay						
Excursion Inlet	$2,626,706	$1,118,977	$2,574,121	$1,096,576	($22,401)	(2.0)
Gustavus	$66,667	$28,400	$65,337	$27,834	($567)	(2.0)
Area H - Yakutat						
Yakutat	$1,312,006	$558,915	$1,285,738	$547,724	($11,190)	(2.0)
Southeast Alaska Total	$26,664,659	$11,359,145	$26,133,059	$11,132,683	($226,462)	(2.0)

Notes:
Net income is estimated to be 42.6 percent of the ex-vessel value based on information from an economic study by ISER (1996). All monetary values are reported in constant 1996 dollars.
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

Table 4.2-5 shows ex-vessel value and net income to commercial troll salmon fishers for Baseline 2. In real (inflation adjusted) terms, the ex-vessel value and net income generated for this baseline would be lower than for Baseline 1. Although coho abundance would remain unchanged for Baseline 1, a decrease in ex-vessel value and net income of 13 percent is predicted for Baseline 2.

Alternative 2—Reduce Chinook Nonretention Fisheries

The ex-vessel value and net income to commercial fishers generated by troll-caught salmon under Alternative 2 are shown in Table 4.2-4 for Baseline 1. The ex-vessel value and net income to commercial salmon fishers in Southeast Alaska would be approximately $26.1 million and $11.1 million, respectively. These values represent a small (2 percent) decrease relative to Alternative 1. Communities that would be most affected include Sitka, Excursion Inlet, and Hoonah.

For Baseline 2, the ex-vessel value and net income to commercial salmon fishers under Alternative 2 are shown in Table 4.2-5. Regionwide, the ex-vessel value of the salmon harvest would decrease by approximately $2.4 million and the net income to commercial salmon fishers would decrease by approximately $1.0 million compared to Alternative 1. This change represents a decrease of 10 percent. Communities that would be most affected include Sitka, Excursion Inlet, and Hoonah.

Alternative 3—No Incidental Take

Under Alternative 3, there would be no commercial troll fishing for salmon in coastal waters. The effect of this alternative would be to forego the social welfare effects of commercial troll fishing for salmon generated under Alternative 1, which are shown in Table 4.2-4 for Baseline 1 and Table 4.2-5 for Baseline 2.

Under Alternative 3, commercial troll salmon fishers would forego the net income associated with troll fishing for salmon under Alternative 1, which is estimated regionwide to be approximately $11.4 million based on an ex-vessel value of $26.7 million for Baseline 1 (Table 4.2-4). Fishing for other species that are available during the salmon season could (theoretically) recapture some of the foregone net income by commercial salmon fishers; however, opportunities for commercial fishing for other species would be limited.

For Baseline 2, commercial salmon fishers would forego approximately $9.8 million in net income regionwide, only a slight decrease relative to Baseline 1 (Table 4.2-5). As indicated above, fishing for other species during the salmon season may recapture some of the foregone net income.

Consumers of Salmon

All Alternatives

As discussed in Appendix D, changes in the commercial harvest of salmon are also expected to have consumer surplus effects, but these effects could not be reliably quantified for this analysis.

Table 4.2-5. Net income to commercial salmon fishers in Southeast Alaska under Alternatives 1 and 2 for Baseline 2.

	Alternative 1		Intermediate (Mixed Stock Fishery) Alternative 1			
				Net Income to Commercial Fishers		
Area/Community	**Ex-Vessel Value**	**Net Income to Commercial Fishers**	**Ex-Vessel Value**	**Value**	**Alternative 2**	**Reduced Chinook Non-retention**
Area A - Ketchikan						
Ketchikan	$1,722,256	$733,681	$1,542,945	$657,295	($76,386)	(10.4)
Metlakatla	$30,056	$12,804	$26,926	$11,470	($1,333)	(10.4)
Area B - Prince of Wales						
Craig	$903,905	$385,064	$809,787	$344,969	($40,094)	(10.4)
Area C - Kake/Petersburg						
Petersburg	$1,634,405	$696,257	$1,464,247	$623,769	($72,487)	(10.4)
Kake	$466,970	$198,929	$418,356	$178,220	($20,710)	(10.4)
Wrangell	$203,439	$86,665	$182,252	$77,639	($9,026)	(10.4)
Area D - Sitka						
Sitka	$10,918,408	$4,651,242	$9,781,618	$4,166,969	($484,273)	(10.4)
Hoonah	$1,810,107	$771,106	$1,621,644	$690,820	($80,285)	(10.4)
Pelican	$1,167,435	$497,327	$1,045,890	$445,549	($51,778)	(10.4)
Elfin Cove	$379,119	$161,505	$339,658	$144,694	($16,810)	(10.4)
Area F - Juneau						
Juneau	$379,119	$161,505	$339,658	$144,694	($16,810)	(10.4)
Area F - Haines/Skagway						
Haines	$30,056	$12,804	$26,926	$11,470	($1,333)	(10.4)
Area G - Glacier Bay						
Excursion Inlet	$2,277,077	$970,035	$2,040,000	$869,040	($100,995)	(10.4)
Gustavus	$57,794	$24,620	$51,781	$22,059	($2,562)	(10.4)
Area H - Yakutat						
Yakutat	$1,137,378	$484,523	$1,018,964	$434,079	($50,444)	(10.4)
Southeast Alaska Total	$23,117,524	$9,848,065	$20,710,652	$8,822,738	($1,025,327)	(10.4)

Notes:
Net income is estimated to be 42.6 percent of the ex-vessel value based on information from ISER (1996). All monetary values are reported in constant 1996 dollars.
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

4.2.2.4 Distributional Effects

Alternative 1—No Action

The analysis of distributional effects focuses on personal income contributions to the commercial fishing industry and businesses that sell goods and services to sport anglers. Direct personal income consists of employee compensation and proprietary income (profits) to persons directly engaged in commercial troll fishing for salmon, and sport fishing-related businesses that sell goods and services to salmon anglers. The effects within important fishing communities in Southeast Alaska are evaluated. Changes in net income to businesses that sell goods and services to anglers also are considered.

Direct personal income generated by ocean sport and commercial troll fishing for salmon under Alternative 1 is shown in Table 4.2-6 for Baseline 1. As shown, ocean sport and commercial troll fishing for salmon generates approximately $25.0 million in direct personal income, with ocean sport fishing accounting for $12.3 million and commercial troll fishing for salmon accounting for $12.7 million. Salmon fisheries generated the most direct personal income in Sitka, followed by Juneau and Ketchikan. For Baseline 2, direct personal income generated by ocean sport and commercial troll fishing for salmon is shown in Table 4.2-7. Compared to Baseline 1, regionwide direct personal income is slightly lower ($24.3 million versus $25.0 million) for Baseline 2; however, direct personal income generated by salmon fisheries is higher in Craig, Juneau, and Gustavus.

Net income to businesses that are directly affected by ocean sport fishing for salmon is shown in Table 4.2-3 for Baselines 1 and 2. Under Alternative 1, these businesses would receive an estimated $3.2 million in annual profits for Baseline 1. Angler spending on ocean salmon fishing would generate approximately $1.1 million, $545,000, and $486,000 in net income for Juneau, Ketchikan, and Sitka businesses, respectively. For Baseline 2, these businesses would receive approximately $3.6 million in annual profits.

Alternative 2—Reduce Chinook Nonretention Fisheries

The direct personal income effects generated by ocean sport and commercial troll fishing for salmon under Alternative 2 are shown in Table 4.2-6 for Baseline 1. Direct personal income to commercial salmon fishers and sport fishing-related businesses that serve salmon anglers in Southeast Alaska would be approximately $24.8 million, a decrease of approximately 1 percent ($253,600) from Alternative 1. For Baseline 2, direct personal income generated by ocean sport and commercial troll fishing for salmon under Alternative 2 is shown in Table 4.2-7. Direct personal income to commercial salmon fishers and sport fishing-related businesses would be approximately $23.2 million, a decrease of less than 5 percent ($1.1 million) relative to Alternative 1. However, the economic value of the sport fishery is unchanged under Alternative 2 so all of the decrease in personal income occurs in the commercial fishery. Those reductions are reflected in Tables 4.2-4 and 4.2-5. Under both Baseline conditions, communities that would be most affected include Sitka, Excursion Inlet, Hoonah, and Ketchikan.

Table 4.2-6. Direct personal income generated in Southeast Alaska under Alternatives 1 and 2 for Baseline 1.

	Alternative 1			Intermediate (Mixed Stock Fishery) Alternative				
						Total Direct PI Generated		
Area/Community	Direct PI Generated by Ocean Sport Fishing for Salmon	Direct PI Generated by Troll Fishing for Salmon	Total Direct PI Generated	Direct PI Generated by Ocean Sport Fishing for Salmon	Direct PI Generated by Troll Fishing for Salmon	Value	Change (relative to Alternative 1)	% Change (relative to Alternative 1)
Area A – Ketchikan								
Ketchikan	$2,116,350	$947,668	$3,064,018	$2,116,350	$928,697	$3,045,047	($18,971)	(0.6)
Metlakatla	$365,093	$16,543	$381,636	$365,093	$16,214	$381,307	($329)	(0.1)
Area B – Prince of Wales								
Craig	$977,465	$497,365	$1,474,830	$977,465	$487,410	$1,464,875	($9,955)	(0.7)
Area C – Kake/Petersburg								
Petersburg	$757,300	$898,250	$1,655,550	$757,300	$881,322	$1,638,622	($16,928)	(1.0)
Kake	$173,555	$256,945	$430,500	$173,555	$251,800	$425,355	($5,145)	(1.2)
Wrangell	$573,710	$111,944	$685,654	$573,710	$109,703	$683,413	($2,241)	(0.3)
Area D – Sitka								
Sitka	$1,889,553	$6,007,849	$7,897,402	$1,889,553	$5,887,568	$7,777,121	($120,281)	(1.5)
Hoonah	$192,817	$996,012	$1,188,829	$192,817	$976,073	$1,168,890	($19,939)	(1.7)
Pelican	$32,056	$642,310	$674,366	$32,056	$629,451	$661,507	($12,859)	(1.9)
Elfin Cove	$10,727	$208,616	$219,343	$10,727	$204,440	$215,167	($4,176)	(1.9)
Area F – Juneau								
Juneau	$4,139,687	$208,616	$4,348,303	$4,139,687	$204,440	$4,344,127	($4,176)	(0.1)
Area F – Haines/Skagway								
Haines	$326,065	$16,543	$342,608	$326,065	$16,214	$342,279	($329)	(0.1)
Area G – Glacier Bay								
Excursion Inlet	$78,741	$1,252,960	$1,331,701	$78,741	$1,227,877	$1,306,618	($25,083)	(1.9)
Gustavus	$289,590	$31,801	$321,391	$289,590	$31,166	$320,756	($635)	(0.2)
Area H – Yakutat								
Yakutat	$388,579	$625,837	$1,014,416	$388,579	$613,307	$1,001,886	($12,530)	(1.2)
Southeast Alaska Total	$12,311,288	$12,719,259	$25,030,547	$12,311,288	$12,465,682	$24,776,970	($253,577)	(1.0)

Notes:
PI = personal income.
Personal income effects for ocean sport fishing were estimated based on expenditure and earnings information presented by Jones & Stokes Associates (1991).
Personal income effects for drift-net fishing for salmon were estimated based on personal income information presented in ADF&G (1999).
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

Table 4.2-7. Direct personal income generated in Southeast Alaska under Alternatives 1 and 2 for Baseline 2.

	Alternative 1			Intermediate (Mixed Stock Fishery) Alternative				
						Total Direct PI Generated		
AREA/COMMUNITY	Direct PI Generated by Ocean Sport Fishing for Salmon	Direct PI Generated by Troll Fishing for Salmon	Total Direct PI Generated	Direct PI Generated by Ocean Sport Fishing for Salmon	Direct PI Generated by Troll Fishing for Salmon	Value	Change (relative to Alternative 1)	% Change (relative to Alternative 1)
Area A – Ketchikan								
Ketchikan	$2,031,729	$821,530	$2,853,259	$2,031,729	$735,997	$2,767,726	($85,533)	(3.0)
Metlakatla	$350,480	$14,337	$364,817	$350,480	$12,844	$363,324	($1,493)	(0.4)
Area B – Prince of Wales								
Craig	$1,401,533	$431,170	$1,832,703	$1,401,533	$386,275	$1,787,808	($44,895)	(2.4)
Area C – Kake/Petersburg								
Petersburg	$695,858	$779,625	$1,475,483	$695,858	$698,458	$1,394,316	($81,167)	(5.5)
Kake	$160,351	$222,749	$383,100	$160,351	$199,559	$359,910	($23,190)	(6.1)
Wrangell	$530,143	$97,042	$627,185	$530,143	$86,936	$617,079	($10,106)	(1.6)
Area D – Sitka								
Sitka	$2,514,760	$5,208,170	$7,722,930	$2,514,760	$4,665,912	$7,180,672	($542,258)	(7.0)
Hoonah	$256,643	$863,436	$1,120,079	$256,643	$773,537	$1,030,180	($89,899)	(8.0)
Pelican	$42,640	$556,876	$599,516	$42,640	$498,898	$541,538	($57,978)	(9.7)
Elfin Cove	$14,273	$180,843	$195,116	$14,273	$162,019	$176,292	($18,824)	(9.6)
Area F – Juneau								
Juneau	$4,289,863	$180,843	$4,470,706	$4,289,863	$162,019	$4,451,882	($18,824)	(0.4)
Area F – Haines/Skagway								
Haines	$263,290	$14,337	$277,627	$263,290	$12,844	$276,134	($1,493)	(0.5)
Area G – Glacier Bay								
Excursion Inlet	$120,473	$1,086,185	$1,206,658	$120,473	$973,097	$1,093,570	($113,088)	(9.4)
Gustavus	$443,402	$27,568	$470,970	$443,402	$24,700	$468,102	($2,868)	(0.6)
Area H – Yakutat								
Yakutat	$211,901	$542,539	$754,440	$211,901	$486,054	$697,955	($56,485)	(7.5)
Southeast Alaska Total	$13,327,339	$11,027,250	$24,354,589	$13,327,339	$9,879,149	$23,206,488	($1,148,101)	(4.7)

Notes:

Personal income effects for ocean sport fishing were estimated based on expenditure and earnings information presented by Jones & Stokes Associates (1991).

Personal income effects for drift-net fishing for salmon were estimated based on personal income information presented in ADF&G (1999).

PI = personal income.

Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

Alternative 3—No Incidental Take

Under Alternative 3, there would be no ocean sport or commercial troll fishing for salmon in coastal waters. The effect of this alternative would be to forego the direct personal income effects of these activities that are generated by Alternative 1, which are shown in Table 4.2-6 for Baseline 1 and Table 4.2-7 for Baseline 2.

Under Alternative 3 for Baseline 1, direct personal income generated by ocean sport and commercial salmon fishing throughout the region could be reduced by up to $25.0 million (Table 4.2-6). The actual amount that would be lost depends on the amount of fishing for other species that is substituted for salmon. In addition, angler spending in the local economy on substitute goods and services would reduce the negative effects on personal income. Assuming that no substitution of spending occurs locally, sport fishing-related businesses that provide goods and serves to salmon anglers would lose approximately $12.3 million in personal income and commercial troll fishers would lose approximately $12.7 million in personal income. Decreases in personal income would be greatest in Sitka, Juneau, and Ketchikan.

For Baseline 2, direct personal income generated by ocean sport and commercial salmon fishing throughout the region could be reduced by up to $24.4 million (Table 4.2-7). As indicated above, the actual amount that would be lost depends on the substitution of spending locally. Assuming that no substitution of spending occurs locally, sport fishing-related businesses that provide goods and services to salmon anglers would lose approximately $13.3 million in personal income and commercial troll fishers would lose $11.0 million in personal income. Decreases in personal income would be greatest in Sitka, Juneau, and Ketchikan.

Under Alternative 3, net income to businesses that rely on spending by salmon anglers would also be reduced. The amount that would be lost would depend on the amount of fishing for other species that would be substituted for salmon. In addition, angler spending in the local economy on substitute goods and services would reduce the negative effects on net income. Assuming that no substitution of spending in the local economy occurs, for Baseline 1 sport fishing-related businesses in Juneau, Ketchikan, and Sitka could lose approximately $1.1 million, $544,000, and $486,000, respectively. For Baseline 2, potential reductions in net income to businesses that rely on spending by salmon anglers would include approximately $1.1 million, $787,000, and $523,000 million to sport fishing-related businesses in Juneau, Sitka, and Ketchikan, respectively. The reduction in net income to sport fishing-related businesses would be expected to be lower because some amount of substitution of local spending seems likely.

4.2.2.5 Social (Community) Effects

Alternative 1—No Action

Commercial fishing communities in Southeast Alaska would receive an estimated annual net income of $11.4 million for Baseline 1 (Table 4.2-4). Net income levels would be highest for the Sitka communities ($5.4 million). Net income levels for commercial fishers would be lowest in the communities of Metlakatla ($14,800) and Haines ($14,800). For Baseline 2, annual net income from commercial fishing would be 13 percent lower

($9.8 million) than for Baseline 1 (Table 4.2-5). Net income generated for commercial fishing communities would be highest in Sitka, Excursion Inlet, and Hoonah, and lowest in Metlakatla, Haines, and Gustavus.

Days spent fishing by sport fishers provide an indication of effects at the community level. As shown in Table 4.2-3, salmon angler days are predicted to total approximately 217,700 under Alternative 1 for Baseline 1. Resident anglers would account for approximately 57 percent of total angling days and nonresident anglers would account for the remaining 43 percent. Sport fishing levels would be highest in Juneau, Ketchikan, and Sitka, which together would account for two-thirds of total angling days in Southeast Alaska. For Baseline 2, angler days would be 9 percent higher, totaling approximately 238,100 days. Juneau, Ketchikan, and Sitka would account for the majority of sport fishing trips (Table 4.2-3).

As shown in Table 4.2-6, personal income for coastal communities in Southeast Alaska would total an estimated $25.0 million under Alternative 1. Baseline 1 with ocean sport fishing and troll fishing for salmon generating virtually equal shares of total personal income. Personal income levels would be highest in Sitka ($7.9 million) and lowest in Elfin Cove ($219,300). For Baseline 2, personal income in Southeast Alaska generated by ocean sport and troll fishing for salmon would total approximately $24.3 million, slightly lower than for Baseline 1 (Table 4.2-7). Personal income levels would be highest in Sitka, and lowest in Elfin Cove.

Alternative 2—Reduce Chinook Nonretention Fisheries

Under Alternative 2, effects on commercial fishing communities in Southeast Alaska from a reduction in commercial harvest would be relatively similar and minor compared to Alternative 1 for Baseline 1. Net income would fall by an estimated 2 percent in all communities (Table 4.2-4), but in absolute terms, the changes would vary by community. Commercial fishing communities experiencing the largest reductions in net income would include Sitka ($107,400) and Excursion Inlet ($22,400). Effects on commercial fishing communities under Alternative 2, Baseline 2 would be much larger compared to Alternative 1. Net income to commercial fishers would fall by more than 10 percent (to $1.0 million); all fishing communities would experience this reduction.

Because of the reductions in ocean salmon harvest levels for commercial fishers, personal income levels for communities in Southeast Alaska would also decrease under Alternative 2, although this reduction would be small (less than 2 percent) relative to Alternative 1, for Baseline 1 (Table 4.2-6). This effect, however, would be substantially larger relative to Baseline 2. As shown in Table 4.2-7, personal income generated by troll fishing for salmon would decrease from $11.0 million under Alternative 1 to $9.9 million under Alternative 2, representing a 10 percent reduction. The significance of income changes to communities would vary according to the relative importance of salmon trolling to the communities. Some of the largest personal income effects under Alternative 2 would likely occur in Sitka ($542,300) and Ketchikan ($85,500); however, these ports have relatively large, diverse economies and effects in smaller communities such as Hoonah ($89,900), Excursion Inlet ($113,100), and Yakutat ($56,500) are proportionally more severe.

For communities dependent on ocean salmon sport fishing, no effects on net income or personal income levels are expected under Alternative 2.

Alternative 3—No Incidental Take

Under Alternative 3 effects on commercial and sport fishers would be significant. For a minority of commercial fishers, salmon trolling may be their only source of income from fisheries. For others, trolling is one of a mix of several fisheries, including halibut and/or blackcod longlining, crabbing, albacore trolling, and/or salmon gillnetting. Halibut, blackcod, and crab fisheries are all fully capitalized and for boats that can participate in multiple fisheries, there is little opportunity to offset the loss of salmon income by increased participation in the other fisheries. In the case of operators who have both troll and gillnet permits, there could be some opportunity to shift effort into the gillnet fishery.

Effects on local fishing and tourist industries from closure of troll and sport fisheries would be significant, with a loss of an estimated $24 to $25 million in personal income for the communities.

The significance of income changes to communities varies according to the relative importance of salmon trolling and sport fishing to the communities. As noted, the largest personal income effects under Alternative 3 would likely occur in Sitka ($7.7 to $7.9 million) and Juneau ($4.4 to $4.5 million); however, these ports have relatively large, diverse economies and effects in smaller communities such as Craig ($1.5 to $1.8 million) and Hoonah ($1.1 to $1.2 million) are proportionally more severe. For instance, total personal income for the Skagway-Yakutat-Angoon (SYA) Borough, which contains the communities of Hoonah, Pelican, Elfin Cove, Excursion Inlet, and Gustavus, is approximately $102 million annually, and the Prince of Wales Island (PWI) Borough where Craig is located has a total personal income of approximately $114 million. By comparison, total personal income is approximately $207 million for the Sitka Borough, $418 million for the Ketchikan-Gateway Borough, and $784 million for the Juneau Borough. As noted in Chapter 3, the PWI and SYA Boroughs have among the highest poverty and unemployment rates in Southeast Alaska.

4.2.3 Comparison of Alternatives

Under Alternative 2, Reduce Chinook Nonretention Fisheries, the chief biological effect relative to Alternative 1, No Action, would be a very small decrease in incidental take of listed chinook stocks, including those from the Snake River fall, Lower Columbia River, and Willamette River spring ESUs. Incidental take of Snake River fall chinook is estimated to decrease approximately 2.6 and 1.8 percent for Baselines 1 and 2, respectively; however, in absolute terms, these changes are small and would decrease the estimated incidental harvest rate from 4.3 percent to 4.2 percent under Baseline 1 and from 4.6 percent to 4.5 percent under Baseline (Table 4.2-2).

Alternative 3 resulted in a modeled decrease of 187 Snake River fall chinook for Baseline 1 and 101 Snake River fall chinook for Baseline 2. The expected net benefits to spawning escapement are discussed in Section 4.5, Cumulative Effects.

As noted above, under Alternative 2, net income to commercial fishers is projected to decrease by 2.0 and 10.4 percent under Baselines 1 and 2, respectively. There would be no change in economic value to the sport sector.

Effects from Alternative 3 on commercial and sport fishers would be substantial. For a minority of commercial fishers, salmon trolling may be the only source of income from fisheries. For others, trolling is one of a mix of several fisheries, including halibut and/or blackcod longlining, crabbing, albacore trolling, and/or salmon gillnetting. Halibut, blackcod, and crab fisheries are all fully capitalized and for boats that can participate in multiple fisheries, there is little opportunity to offset the loss of salmon income by increased participation in the other fisheries. In the case of operators who have both troll and gillnet permits, there could be some opportunity to shift effort into the gillnet fishery. Effects on local fishing and tourist industries from closure of troll and sport fisheries would result in with a loss of approximately $24 to $25 million in personal income for the communities. The significance of income changes for the communities will vary according to the relative importance of salmon trolling and sport fishing to each community. As noted, the largest personal income effects are projected to occur in Sitka, Juneau, and Ketchikan; however, these ports have relatively large, diverse economies and effects in smaller communities such as Craig, Hoonah, Excursion Inlet, and Yakutat are proportionally more severe and may be expected to have larger effects on employment, income, and poverty levels.

An important aspect of Alternative 2 is its inherent economic incentive for trollers to maximize chinook encounters during the coho-directed fishery. Although Alternative 2 prohibits fishing in areas of high chinook concentration, trollers, given the economic incentive, may find ways to achieve higher chinook catch rates than those reported for the CNR fisheries. Under Alternative 2, there is a possibility of increasing the chinook catch rates to more than those observed during past CNR fishing periods.

Because the fishery would still be capped by the abundance-based quota, it would be necessary to resort to CNR fishing periods or the use of additional management actions designed to slow the catch rate and, thus, eliminate the need for CNR fishing.

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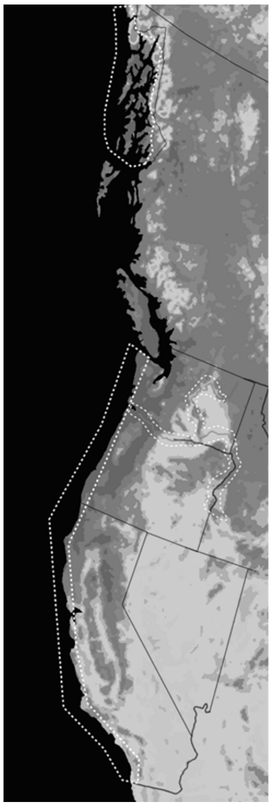
4.3 Pacific Coast

4.3.1 Effects on the Biological Environment



This section presents an assessment of the biological effects for Alternative 1—No Action, Alternative 2—Mark-Selective Fisheries, and Alternative 3—No Incidental Take. Effects under Alternatives 2 and 3 are described in relation to Alternative 1. Biological effects are described in terms of the short-term and long-term for listed and unlisted species including salmon and steelhead, mammals, birds, and lower trophic level species.

4.3.1.1 Analytic Approach and Assumptions

Analytic Steps

An analysis of the short-term effects on the biological environment was conducted as listed below. Appendix E contains a more complete description of assumptions and methods.

1. Conservation objectives in the current fishery management plans for listed and unlisted stocks that are encountered in the fisheries were used as the basis for limiting fisheries. Conservation objectives were expressed in terms of ocean harvest rates or impact ceilings (see Section 2.4.2.1b).
2. A sensitivity analysis in the calculations determined the most constraining conservation objective for each fishery management area, which then became the limiting criterion for the modeled fishery. For instance, central Oregon fisheries were limited by harvest rate for OCN coho in some scenarios and Snake River fall chinook in others.
3. Two baselines (Baseline 1 and Baseline 2) providing indices of abundance for key stocks were formulated using data from 1988 to 1997 because the effects of alternative management approaches are sensitive to changes in abundance and because stock abundance is variable.
4. Baseline 1 (based on 1988 to 1993 data) represents a fairly broad range of ocean survival conditions, with a relatively high abundance of coho in some years and a relatively low abundance in others. Baseline 2 (1994 to 1997 data) represents more recent conditions, with a low abundance of many coho stocks, high abundance of chinook stocks from central California, and an abundance of other chinook stocks similar to or lower than those of Baseline 1. Other demarcations could have been used for baselines or a single baseline could have been used.
5. The proportion of fish originating from hatchery and naturally spawning parents was estimated for stock groups or ESUs.
6. Hypothetical fishing seasons were modeled for Alternatives 1 and 2. Alternative 1 used the suite of management measures specified in Tables 4.3-1 and 4.3-2, and fishery constraints were the harvest rates on species retained or the incidental mortality on species released. Alternative 2 assumed fisheries were mark-selective and targeted the hatchery component of the runs, employing management measures used under Alternative 1 where they would further reduce effects to weak or listed stocks. Fisheries were constrained by the incidental mortality of unmarked (natural) fish released in the fishery.

Table 4.3-1. Description of Pacific Coast alternatives by fishery management area for Baseline 1.

		Troll				Sport			
FMA	**Limiting Stock(s)**	**Season**	**Gear Regs1/**	**Target**	**Species Retained2/**	**Season**	**Gear Regs1/**	**Target**	**Species Retained2/**
Alternative 1									
North of Falcon	Puget Sound or Coastal coho	July 1-21	1, 2	Chinook	Chinook: H, W	July 1-21	1	Both	Chinook: H, W Coho: H, W
Falcon-KMZ	Snake River fall chinook	May-June Aug-mid Oct	1, 2	Chinook	Chinook: H, W	May and Aug	1	Both	Chinook: H, W Coho: H, W
KMZ	Klamath River chinook	May-mid Jun	1, 2	Chinook	Chinook: H, W	May-mid June	1	Chinook	Chinook: H, W
South of KMZ	Sacramento winter chinook	May-Oct	1, 2	Chinook	Chinook: H, W	May-Oct	1	Chinook	Chinook: H, W
Alternative 2, Option A									
North of Falcon	Puget Sound chinook	May-Oct	1, 2	Chinook	Chinook: H Coho: H	May-Oct	1	Both	Chinook: H Coho: H
Falcon-KMZ	OCN coho	May-Oct	1, 2	Chinook	Chinook: H Coho: H	May-Oct	1	Both	Chinook: H Coho: H
KMZ	Klamath River chinook	May-Oct	1, 2	Chinook	Chinook: H	May-Oct	1	Chinook	Chinook: H
South of KMZ	Sacramento winter chinook	May-Oct	1, 2	Chinook	Chinook: H	May-Oct	1	Chinook	Chinook: H
Alternative, Option B									
North of Falcon	Puget Sound chinook	July	1, 2	Chinook	Chinook: H Coho: H	July	1	Both	Chinook: H Coho: H
Falcon-KMZ	OCN coho	May1-July 1, Aug 1-Oct 31	1, 2	Chinook	Chinook: H Coho: H	May 1-July 1, Aug 1-Oct 31	1	Both	Chinook: H Coho: H
KMZ	Klamath River chinook	May-Oct	1, 2	Chinook	Chinook: H	May-Oct	1	Chinook	Chinook: H
South of KMZ	Sacramento winter chinook	May-Oct	1, 2	Chinook	Chinook: H	May-Oct	1	Chinook	Chinook: H

Notes:
1/ Gear: 1 = barbless hooks, 2 = lines limited to 4.
2/ Current minimum size limits for troll chinook (26 inches) and sport chinook (20 inches) pertain. There is no minimum size limit for sport coho.
FMA = fishery management area.
H = hatchery, w = wild
KMZ = Klamath management zone
OCN = Oregon Coastal Natural

Table 4.3-2. Description of Pacific Coast alternatives by FMA for Baseline 2.

FMA	Limiting Stock(s)	Troll				Sport			
		Season	Gear Regs[1/]	Target	Species Retained[2/]	Season	Gear Regs[1/]	Target	Species Retained[2/]
Alternative 1									
North of Falcon	Puget Sound or Coastal coho	Aug 1-19	1, 2	Chinook	Chinook: H, W	July 1-21	1	Both	Chinook: H, W Coho: H, W
Falcon-KMZ	OCN coho	May, June, Aug	1, 2	Chinook	Chinook: H, W	May and Aug	1	Both	Chinook: H, W Coho: H, W
KMZ	Klamath River chinook	May-mid June	1, 2	Chinook	Chinook: H, W	May-mid June	1	Chinook	Chinook: H, W
South of KMZ	Sacramento winter chinook	May-Oct	1, 2	Chinook	Chinook: H, W	May-Oct	1	Chinook	Chinook: H, W
Alternative 2, Option A									
North of Falcon	Puget Sound chinook	July-Oct	1, 2	Chinook	Chinook: H Coho: H	May-Oct	1	Both	Chinook: H Coho: H
Falcon-KMZ	OCN coho	May-Oct	1, 2	Chinook	Chinook: H Coho: H	May-Oct	1	Both	Chinook: H Coho: H
KMZ	Klamath River chinook	May-mid July	1, 2	Chinook	Chinook: H	May-mid July	1	Chinook	Chinook: H
South of KMZ	Sacramento winter chinook	May-Oct	1, 2	Chinook	Chinook: H	May-Oct	1	Chinook	Chinook: H
Alternative 2, Option B									
North of Falcon	Puget Sound or Coastal coho	July-Oct	1, 2	Chinook	Chinook: H Coho: H	May-Oct	1	Both	Chinook: H Coho: H
Falcon-KMZ	OCN coho	May-Oct	1, 2	Chinook	Chinook: H Coho: H	May-Oct	1	Both	Chinook: H Coho: H
KMZ	Klamath River chinook	May-mid July	1, 2	Chinook	Chinook: H	May-mid July	1	Chinook	Chinook: H
South of KMZ	Sacramento winter chinook	May-Oct	1, 2	Chinook	Chinook: H	May-Oct	1	Chinook	Chinook: H

Notes:
1/ Gear: 1 = barbless hooks, 2 = lines limited to 4.
2/ Current minimum size limits for troll chinook (26 inches) and sport chinook (20 inches) pertain. There is no minimum size limit for sport coho.
FMA = fishery management area.
H = hatchery, w = wild
KMZ = Klamath management zone
OCN = Oregon Coastal Natural

7. To calculate the harvest and the number of angler trips under each proposed alternative, the model assumed commercial and sport catch rates would be the same as the baseline. The model allowed commercial or sport fisheries to be open or closed any given day between April 1 and October 30. Combinations of openings and closures were tested to produce the maximum fishing opportunity in terms of angler trips and maximum harvest value for commercial fishers.

Options under Alternative 2—Mark-Selective Fisheries

Option A was modeled to maximize season duration (increase fishing opportunity) in each fishery management area while meeting or exceeding conservation objectives for fisheries. Under Option A, effects on listed Lower Columbia River and Puget Sound chinook ESUs would increase but effects to other listed ESUs would be reduced. Option B was modeled to maximize escapement of natural stocks (decrease effects on all listed ESUs), including those from listed ESUs, and assumed season duration equal or similar to that under Alternative 1. Option B allows the benefits of selective fisheries to accrue to escapement, whereas in Option A they accrue to the fishery.

Conservation Objectives

Conservation objectives that have constrained Council-managed fisheries are the ESA goals of decreasing ocean effects on Sacramento River winter run, Snake River fall run, and Oregon Coastal and Southern Oregon/Northern California coastal coho. Conservation objectives for the Puget Sound chinook ESU have not previously been a constraint to most Pacific Coast fisheries because ocean fishing effects on these stocks are typically low; however, their recent listing has increased the likelihood of the Council limiting fisheries north of Cape Falcon. Klamath River chinook and some coho runs from the Puget Sound or Washington coastal ESUs are unlisted stocks that frequently constrain fisheries. Conservation objectives for listed chinook ESUs (expressed as ocean harvest rates) are the same for both Baseline 1 and 2. The harvest rate for OCN coho for Baseline 1 is assumed in the model to be 20 percent and is assumed to be 13 percent in the model for Baseline 2. This is in keeping with Amendment 13 to the Pacific Coast Salmon Plan, which specifies harvest rates on OCN coho according to escapement of parent broods and ocean conditions.

Specification of Management Measures

Tables 4.3-1 and 4.3-2 summarize the limiting stock(s), seasons, target species, gear regulations, and species retention for each fishery management area under Alternatives 1 and 2 for Baselines 1 and 2. Alternative 3 is discussed at the end of this section.

4.3.1.2 Harvests and Incidental Mortalities

Alternative 1—No Action

In the fishery modeled for Alternative 1, chinook and coho harvest for the Council management area would be approximately 735,000 and 142,000, respectively (Table 4.3-3). The average of annual observed harvests from 1988 to 1993 (Baseline 1) would be 965,000 chinook and 820,000 coho. In general, the modeled harvests were lower because conservation objectives under Alternative 1 are more stringent than those actually applied from 1988 to 1993, particularly for coho.

Table 4.3-3. Modeled annual average commercial and sport harvest in Pacific Coast fisheries under Alternatives 1 and 2 for Baseline 1.[1/]

FMA	Troll: Days in Season	Troll: Target	Troll: Harvest Chinook	Troll: Harvest Coho	Sport: Days in Season	Sport: Target	Sport: Harvest Chinook	Sport: Harvest Coho	Total: Harvest Chinook	Total: Harvest Coho
Alternative 1										
North of Falcon	21	Chinook	6,217	0	21	Both	6,930	72,228	13,147	72228
Falcon-KMZ	120	Chinook	131,698	0	120	Both	5,004	69,428	136,702	69,428
KMZ	48	Chinook	9,910	0	48	Chinook	7,654	0	17,564	0
South of KMZ	184	Chinook	496,452	0	184	Chinook	71,565	0	568,017	0
Total			**644,277**	**0**			**91,153**	**141,656**	**735,430**	**141,656**
Alternative 2, Option A										
North of Falcon	184	Chinook	52,514	40,368	184	Both	15,058	143,475	67,571	183,843
Falcon-KMZ	184	Chinook	161,908	101,466	184	Both	6,943	148,814	168,851	250,280
KMZ	184	Chinook	17,771	0	184	Chinook	23,840	0	41,611	0
South of KMZ	184	Chinook	370,665	0	184	Chinook	53,433	0	424,098	0
Total			**602,858**	**141,834**			**99,274**	**292,289**	**702,131**	**434,123**
Alternative 2, Option B										
North of Falcon	21	Chinook	4,540	6,113	21	Both	5,061	52,679	9,602	58,792
Falcon-KMZ	120	Chinook	109,093	24,989	184	Both	3,632	54,489	112,725	79,479
KMZ	48	Chinook	7,176	0	48	Chinook	5,543	0	12,718	0
South of KMZ	184	Chinook	370,665	0	184	Chinook	53,433	0	424,098	0
Total			**491,474**	**31,102**			**67,669**	**107,168**	**559,143**	**138,271**

Notes:
1/ Actual harvests under each alternative would vary.
FMA = fishery management area.
KMZ = Klamath management zone

Under Alternative 1, Baseline 2, the chinook and coho harvests would be approximately 814,000 and 60,000, respectively (Table 4.3-4). The average of annual observed harvests from 1994 to 1997 was 865,000 chinook and 51,000 coho. Modeled harvests for Baseline 2 are more similar to observed harvests from 1994 to 1997, as would be expected given that management constraints were similar in this period to those used in the model.

Alternative 2—Mark-Selective Fisheries, Option A

In the fishery modeled for Alternative 2, Option A (Baseline 1), Pacific Coast chinook harvest (702,000) would be 5 percent less than under Alternative 1. Compared to Alternative 1, modeled chinook harvests under Alternative 2, Option A were 414 percent higher for North of Falcon (68,000), 24 percent higher for Falcon-KMZ (169,000), 137 percent higher in the KMZ (42,000), and 28 percent lower South of the KMZ (424,000). A larger chinook harvest was indicated in the three northerly areas because of increased season length. South of the KMZ, where there was no season length restriction under Alternative 1, landed harvest decreased in approximate proportion to the percentage of unmarked fish, which were released in the mark-selective fishery. Coho harvest (434,000) increased 206 percent from Alternative 1 due to increases in coho harvest in the North of Falcon and Falcon-KMZ area; there were no coho harvests in the other areas under this alternative. Coho harvest for Baseline 2 was 47 percent less than that observed for Baseline 1 (Table 4.3-3 and Figure 4.3-1).

Under Alternative 2, Option A (Baseline 2), the chinook harvest (624,000) would be expected to decrease 23 percent compared to Alternative 1 because of reduced sport and commercial harvest South of the KMZ (459,000) and reduced commercial harvest from Falcon-KMZ (107,000). Coho harvest (224,000) would increase 273 percent compared to Alternative 1. Coho harvests would be 192 percent higher North of Falcon (100,000) and 380 percent higher in the Falcon-KMZ area (123,000) resulting from longer sport seasons (Table 4.3-4 and Figure 4.3-1).

Alternative 2—Mark-Selective Fisheries, Option B

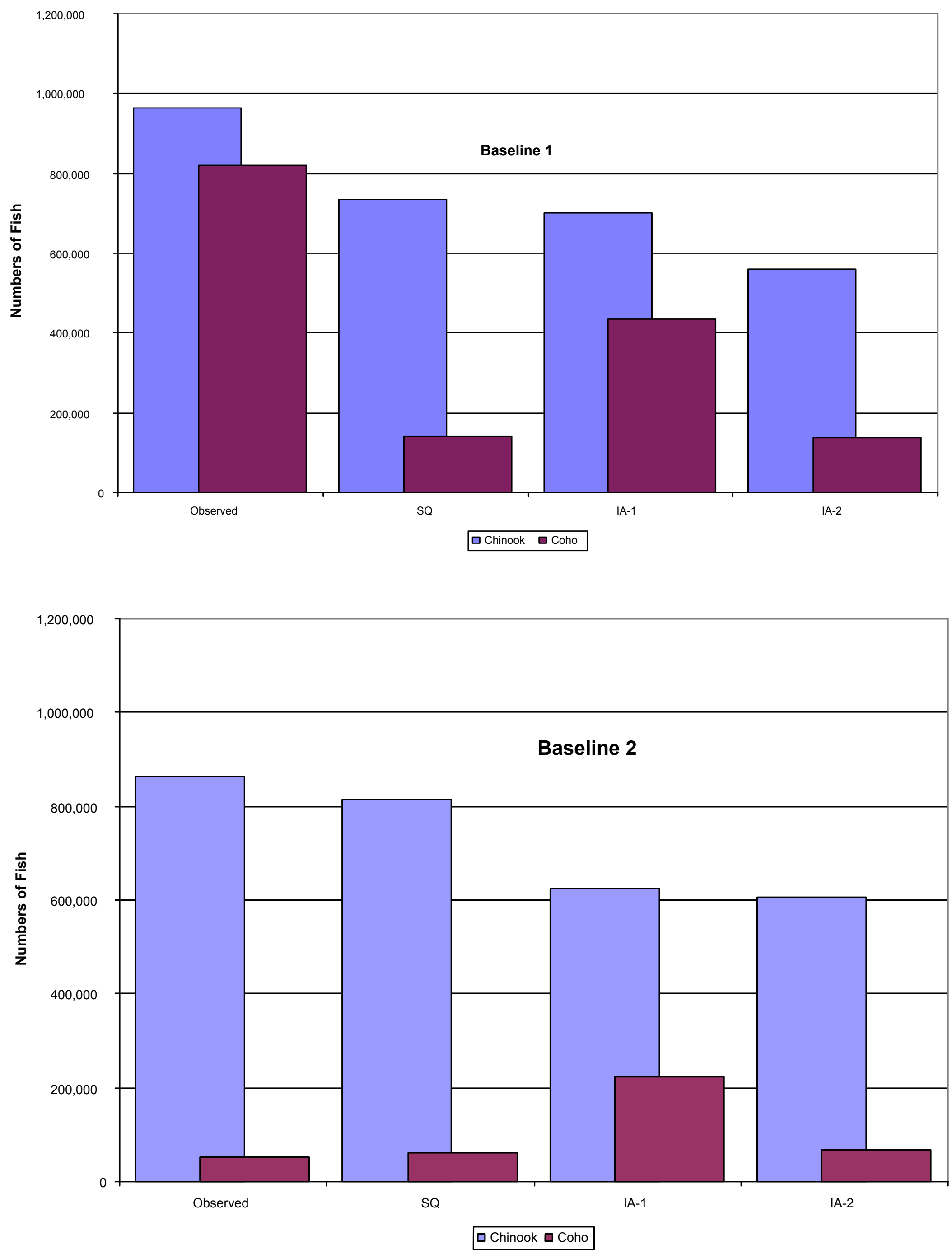
Under Alternative 2, Option B (Baseline 1) chinook harvest for the Pacific Coast area (559,000) would be 24 percent less than under Alternative 1 and 41 percent less than the average annual observed harvest. Reductions in chinook harvest would range from 12 percent in the KMZ to 28 percent south of the KMZ. There would be little change in the total coho harvest, although a greater portion of coho would be taken in the Falcon-KMZ area and a lesser proportion North of Falcon under Alternative 2, Option B than under Alternative 1 (Table 4.3-3 and Figure 4.3-1).

Under Alternative 2, Option A (Baseline 2), the chinook harvest (607,000) would be approximately 26 percent less than under Alternative 1 and 30 percent less than the average annual observed harvest from 1994 to 1997. Chinook harvests would decrease 20 to 27 percent in all FMAs. The coho harvest (68,000) would be approximately 14 percent less than under Alternative 1 but 33 percent more than the observed average harvest (Table 4.3-4 and Figure 4.3-1).

Table 4.3-4. Modeled annual average commercial and sport harvest in Pacific Coast fisheries under Alternatives 1 and 2 for Baseline 2.[1/]

FMA	Troll				Sport				Total	
	Days in Season	Target	Harvest		Days in Season	Target	Harvest		Harvest	
			Chinook	Coho			Chinook	Coho	Chinook	Coho
Alternative 1										
North of Falcon	17	Chinook	14,420	0	17	Coho	220	34,247	14,640	34,247
Falcon-KMZ	153	Chinook	137,846	0	123	Both	2,813	25,724	140,659	25,724
KMZ	40	Chinook	6,381	0	40	Chinook	5,250	0	11,631	0
South of KMZ	184	Chinook	466,042	0	184	Chinook	181,457	0	647,498	0
Total			**624,689**	**0**			**189,740**	**59,971**	**814,428**	**59,971**
Alternative 2, Option A										
North of Falcon	61	Chinook	21,355	0	122	Coho	485	100,136	21,840	100,136
Falcon-KMZ	184	Chinook	100,675	7,385	184	Both	6,690	115,981	107,365	123,365
KMZ	103	Chinook	11,294	0	103	Chinook	23,765	0	35,058	0
South of KMZ	184	Chinook	330,657	0	184	Chinook	128,744	0	459,400	0
Total			**463,981**	**7,385**			**159,684**	**216,117**	**623,663**	**223,501**
Alternative 2, Option B										
North of Falcon	19	Chinook	11,515	0	19	Coho	176	27,961	11,691	27,961
Falcon-KMZ	153	Chinook	100,675	7,385	123	Both	2,187	32,733	102,862	40,118
KMZ	40	Chinook	4,627		40	Chinook	3,806	0	8,433	0
South of KMZ	184	Chin	348,060		184	Chinook	135,520	0	483,579	0
Total			**464,877**	**7,385**			**141,689**	**60,694**	**606,565**	**68,079**

Notes:
1/ Actual harvests under each alternative would vary.
FMA = fishery management area.
KMZ = Klamath management zone



Source: Council 1999b and NRC.

Figure 4.3-1. Combined commercial and sport harvests of chinook and coho salmon in Pacific Coast fisheries under Alternatives 1 and 2 for Baselines 1 and 2.

Alternative 3—No Incidental Take

Under Alternative 3, reductions in harvest would be equivalent to catches observed in the respective baseline or estimated under the alternatives. Foregone harvest in the ocean would result in greater escapements to inside waters such as Puget Sound, San Francisco Bay, the Columbia River, and the Sacramento River where, depending on the segregation of critical stocks, some harvest might be possible. As noted, these fisheries are regulated by state and Tribal managers and would be subject to review by NMFS through a Section 10 consultation.

4.3.1.3 Naturally Spawning Salmon

Naturally produced chinook are believed to account for approximately 25 percent of the total Council management area abundance of chinook stocks. Tables 4.3-5 and 4.3-6 show harvest effects on naturally spawning salmon and listed salmon by FMA under the proposed alternatives for Baselines 1 and 2, respectively.

Alternative 1—No Action

Because there were no CNR fisheries modeled for Alternative 1, all effects to (adult) wild chinook are from harvest. According to the model, 186,000 wild chinook would be affected (Table 4.3-5) for Baseline 1. More than 90 percent would be from the Central Valley fall run, which is a candidate for listing. Less than 3 percent of harvested wild stocks would be from currently listed ESUs.

Harvest and incidental mortality of wild coho would be approximately 40,000 (Table 4.3-5). Approximately 22 percent of effects on the wild component would be to listed coho stocks. Ninety-five percent of coho effects would occur in the North of Falcon and Falcon-KMZ areas where the fisheries modeled included coho retention for sport or sport and commercial fishers.

For Baseline 2, there would be approximately 194,000 wild chinook and 20,000 wild coho killed under Alternative 1 (Table 4.3-6).

Alternative 2—Mark-Selective Fisheries, Option A

Effects on wild chinook under Alternative 2, Option A would be from catch-and-release mortality; there would be 76,000 effects on wild chinook for Baseline 1 (Table 4.3-5). Eighty-two percent of the effects would be attributable to Central Valley fall chinook and slightly more than 8 percent were attributable to chinook from listed ESUs. Catch-and-release mortality of wild coho would be approximately 38,000, with 22 percent affecting listed ESUs. Approximately 76 percent of the effects would be in areas north of the KMZ where coho fisheries are open.

There would be approximately 61,000 effects on wild chinook for Baseline 2 under Alternative 2, Option A and 62,000 effects under Alternative 2, Option B. At least 90 percent of these effects for both baselines would be on the Central Valley fall run and 1.8 to 3.3 percent of the effects would be on listed ESUs.

Table 4.3-5. Summary of model-generated harvest and harvest effects under Alternatives 1 and 2 (Baseline 1) for Pacific Coast FMAs.

FMA	Harvest		Natural Effects		Listed Effects	
	Chinook	Coho	Chinook	Coho	Chinook	Coho
Alternative 1						
North of Falcon	13,147	72,228	3,545	23,283	2,627	1,816
Falcon-KMZ	136,702	69,428	35,845	14,516	1,683	4,891
KMZ	17,564		3,200	960	28	324
South of KMZ	568,017		143,919	1,513	208	1,389
Total	**735,430**		**186,196**	**40,272**	**4,546**	**8,420**
Alternative 2, Option A						
North of Falcon	67,571	183,843	7,067	16,969	5,237	1,324
Falcon-KMZ	168,851	250,280	20,916	11,885	982	4,005
KMZ	41,611		3,825	4,707	33	1,533
South of KMZ	424,098		44,107	4,053	64	1,320
Total	**702,131**	**434,123**	**75,819**	**37,615**	**6,316**	**8,181**
Alternative 2, Option B						
North of Falcon	9,602	58,792	875	4,131	648	376
Falcon-KMZ	112,725	79,479	11,599	1,813	545	1,357
KMZ	12,718		1,249	960	11	324
South of KMZ	424,098		44,107	4,123	64	1,389
Total	**559,144**	**138,721**	**57,734**	**11,027**	**1,267**	**3,447**

Notes:
FMA = fishery management area
KMZ = Klamath management zone
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. The catch would be zero.

Table 4.3-6. Summary of model-generated harvest and harvest effects under Alternatives 1 and 2 (Baseline 2) for Pacific Coast FMAs.

Alternative 1						
North of Falcon	14,640	34,247	4,180	14,220	2,753	1,517
Falcon-KMZ	140,659	25,724	23,336	4,898	370	2,518
KMZ	11,631		3,198	107	24	55
South of KMZ	647,498		163,919	51	91	26
Total	**814,428**	**59,970**	**194,242**	**19,277**	**3,238**	**4,116**
Alternative 2, Option A						
North of Falcon	21,840	100,136	2,823	14,759	1,860	1,746
Falcon-KMZ	107,365	123,365	5,298	4,914	84	2,526
KMZ	35,058		3,200	421	24	216
South of KMZ	459,400		49,529	51	28	17
Total	**623,664**	**223,502**	**60,732**	**20,144**	**1,995**	**4,505**
Alternative 2, Option B						
North of Falcon	11,691	27,961	1,440	5,129	948	607
Falcon-KMZ	102,862	40,118	10,012	2,191	159	1,128
KMZ	8,433		818	103	6	53
South of KMZ	483,579		49,529	51	28	26
Total	**606,565**	**68,079**	**61,680**	**7,474**	**1,141**	**1,812**

Notes:
FMA = fishery management area
KMZ = Klamath management zone
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. The catch would be zero.

Alternative 2—Mark-Selective Fisheries, Option B

Under Alternative 2, Option B (Baseline 1), approximately 58,000 wild chinook would be killed. Ninety-two percent would be from the Central Valley fall ESU and approximately 2 percent from listed ESUs. Catch-and-release mortality of wild coho would be approximately 11,000, with 31 percent affecting listed ESUs (Table 4.3-5).

Under Alternative 2, Option A (Baseline 2), there would be approximately 20,000 effects on wild coho and 7,000 effects on wild coho under Alternative 2, Option B (Baseline 2); 22 to 23 percent of these effects were on listed ESUs (Table 4.3-7). The reduction in OCN effects for Baseline 2 was due to the incorporation in the model of the lower harvest rate required under Council Amendment 13 for the conditions observed in the baseline (13 percent vs. 20 percent in Baseline 1).

Alternative 3—No Incidental Take

For Baseline 1 the analysis indicated that curtailment of commercial and sport fisheries in the Council management area would result in approximately 186,000 fewer effects on wild chinook, which includes approximately 4,500 effects on listed ESUs, compared to Alternative 1 (Table 4.3-5). The largest decreases in effects for unlisted stocks of chinook would be to the Central Valley fall run ESU (170,000) and the Klamath ESU (8,000). The largest apparent decrease in take of listed chinook ESUs (approximately 2,800) would be for the Lower Columbia River ESU. There would be approximately 40,000 fewer effects on wild coho; 8,000 from listed ESUs.

Under Alternative 3 (Baseline 2), the effects on wild chinook stocks would decrease by approximately 194,000 (Table 4.3-6), including 181,000 from the Central Valley fall run and 7,600 from the Klamath run. Effects on chinook from listed ESUs would decrease by approximately 3,200 fish and the Lower Columbia River ESU would account for approximately two-thirds of these.

4.3.1.4 Other Naturally Produced Salmonids

Because pink and chum salmon harvests are very small in Pacific Coast fisheries, they were not modeled. An encounter of steelhead in ocean salmon fisheries is "inconsequential to extremely rare" (Council 1999a); therefore, steelhead was also not modeled. Steelhead may not be retained in the non-treaty commercial fisheries but may be kept in recreational and treaty fisheries. NMFS has determined that Council-managed salmon fisheries are not likely to jeopardize the continued existence of the listed steelhead ESUs (NMFS 1998a).

Cutthroat trout are not targeted and there is no record of any being caught in Pacific Coast salmon fisheries. The Salmon Technical Team of the Council has concluded that the harvest of cutthroat is almost nonexistent (1996). NMFS has determined that Council-managed fisheries are not likely to jeopardize the continued existence of Umpqua River cutthroat trout (NMFS 1998a).

4.3.1.5 Listed Chinook and Coho ESUs

Fish from 13 chinook ESUs are known to be taken in Pacific Coast fisheries. Nine of these are listed as either threatened or endangered, including Sacramento River winter run, Central Valley spring run, California Coastal, Snake River fall run, Puget Sound, Lower

Columbia River, and Upper Willamette River spring run. Fish from the Snake River spring/summer run and Upper Columbia River spring run may also be taken but it is believed the numbers are so small as to be undetectable (Council 1999a). The Central Valley fall run ESU is a candidate for listing.

Sufficient data were available to include nine ESUs in the modeling of alternatives.[5] The calculated effects on these ESUs from harvest or incidental mortality for Baselines 1 and 2 under the proposed alternatives are shown in Tables 4.3-7 and 4.3-8 as harvest rates. These calculations accurately reflect effects of the alternatives relative to each other by providing a reasonable approximation of harvest rates, which existed historically or would be realized in fisheries conducted according to the parameters in the model. The necessity, however, of combining data from a variety of sources and models to construct a coastwide model and of abridging or approximating some estimation procedures makes direct comparison of these harvest rates with other published rates problematic.

4.3.1.6 Non-Salmonid Fish Species

Alternative 1—No Action

Various groundfish species are caught incidentally in ocean salmon fisheries. These species are managed under the Council's groundfish FMP. The annual management measures anticipate and take into account incidental groundfish catch in the ocean salmon fishery. During the groundfish process, expected groundfish bycatch in the salmon fishery is estimated, based on the previous year's incidental catch levels. While the levels of salmon catch fluctuate from year to year, the amount of groundfish taken as incidental catch is very low so that changes in the salmon fishery do not substantially alter the projections for harvest-related mortality in the groundfish fishery (PFMC 2002).

Other Council managed species such as halibut, highly migratory species (draft FMP) , and coastal pelagic species are also landed jointly with salmon. For all of these stocks, fish caught on the same trip with salmon are documented. Data on the commercial segment of these fisheries show the co-occurrence rates for salmon and these other Council-managed species is low, as well as for non-Council-managed species. Changes in the salmon fishery are not expected to have a substantial impact on the directed fisheries for the non-salmon stocks (PFMC 2002).

Alternative 2—Mark-Selective Fisheries and Alternative 3—No Incidental Take

Under Alternative 2, effects on non-salmonid fish species would be the same as under Alternative 1, except interactions with incidentally caught fish species would be related to changes in fishing effort. Because effects on other fish species are minimal, any change would likely be unmeasurable.

[5] The harvest rate for the Central Valley spring run was inferred from the literature.

Table 4.3-7. Model-generated harvest rates on chinook salmon ESUs in Pacific Coast fisheries for Baselines 1 and 2 under Alternatives 1 and 2.

ESU	Status	Included in Model	% Harvest Rate: Alternative 1	Alternative 2: Option A	Alternative 2: Option B
Baseline 1					
Sacramento River Winter Run	E	yes	18	5	5
Central Valley Spring Run	T	no	< 73	< 27	< 23
Central Valley Fall Run	C	yes	73	27	23
California Coastal	T	no	Insufficient Data		
Southern Oregon and Northern California Coastal	NW	no	Insufficient Data[1/]		
Upper Klamath and Trinity River	NW	yes	6	3	2
Oregon Coast	NW	yes	1	1	< 1
Washington Coast	NW	no	Insufficient Data		
Puget Sound	T	yes	3	5	1
Lower Columbia River	T	yes	6	8	2
Upper Willamette River Spring Run	T	yes	1	1	< 1
Upper Columbia River Summer/Fall Run	NW	yes	1	1	< 1
Upper Columbia River Spring Run	E	no	Effects Unmeasurable		
Snake River Fall Run	T	yes	10	7	3
Snake River Spring/Summer Run	T	no	Effects Unmeasurable		
Total			**21**	**9**	**7**
Baseline 2					
Sacramento River Winter Run	E	yes	8	2	2
Central Valley Spring Run	T	no	< 73	< 19	< 22
Central Valley Fall Run	C	yes	73	27	23
California Coastal	T	no	Insufficient Data		
Southern Oregon Northern California Coastal	NW	No	Insufficient Data[1/]		
Upper Klamath and Trinity River	NW	yes	7	2	2
Oregon Coast	NW	yes	< 1	< 1	< 1
Washington Coast	NW	no	Insufficient Data		
Puget Sound	T	yes	2	1	1
Lower Columbia River	T	yes	7	4	2
Upper Willamette Spring Run	T	yes	1	1	< 1
Upper Columbia Summer/Fall Run	NW	yes	1	1	< 1
Upper Columbia Spring Run	E	no	Effects Unmeasurable		
Snake River Fall Run	T	yes	8	3	3
Snake River Spring/Summer Run	T	no	Effects Unmeasurable		
Total			**24**	**7**	**7**

Notes:
1/ Effects may be similar to Upper Klamath and Trinity ESU.
Harvest rates are given for wild-spawning chinook.
T= threatened, E=endangered, C = candidate, NW = not warranted
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. The catch would be zero.

Table 4.3-8. Model-generated harvest rates on coho salmon ESUs in Pacific Coast fisheries for Baselines 1 and 2 under Alternatives 1 and 2.

ESU	Status	Included in Model	% Harvest Rate: Alternative 1	Alternative 2: Option A	Alternative 2: Option B
Baseline 1					
Oregon Coast Natural	T	yes	8	8	3
Southern Oregon and Northern California Coastal	T	yes	8	8	3
California Coastal	T	no		Unknown	
Puget Sound/Olympic Peninsula 1	C/NW	yes	5	4	1
Puget Sound/Olympic Peninsula 2	C/NW	yes	5	5	1
Total					
Baseline 2					
Oregon Coast Natural	T	yes	10	10	4
Southern Oregon and Northern California Coast	T	yes	10	10	4
California Coastal	T	no		Unknown	
Puget Sound/Olympic Peninsula 1	C/NW	yes	8	7	2
Puget Sound/Olympic Peninsula 2	C/NW	yes	12	13	3
Total					

Notes:
Harvest rates are given for wild-spawning coho.
T = threatened, E = endangered, C = candidate, NW = not warranted
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. The catch would be zero.

4.3.1.7 Mammalian Species

Alternative 1—No Action

Effects on higher trophic level species occur through entanglement with fishing gear, competition with fisheries for prey, and alteration of the food web dynamics caused by fishery removals (Council 1999a). The complexity of ecosystem interactions and lack of data make it difficult to distinguish between a natural or anthropogenic effect on the carrying capacity of the ecosystem of marine mammals or seabirds in the central north Pacific Ocean. Different trophic levels and key species have different response times and scales. Pacific Coast salmon fisheries are not believed to contribute to changes in marine mammal or seabird populations (Council 1999a).

Marine mammals, particularly seals and sea lions on the Pacific Coast, are known to forage on salmon as well as other fish. Many observers point to the natural feeding behavior of marine mammals on oceanic and inshore salmon stocks as one of the reasons for decline in salmon abundance over the last two decades. In general, the harbor seal and California sea lion populations have increased under the protection of the MMPA of 1972, but it is not possible to attribute a decrease in salmon abundance to this effect alone because of the complexity of the ecosystem interactions (NMFS 1997a).

Pinnipeds and smaller cetaceans are considered opportunistic and feed on a wide variety of fish species including Pacific whiting, rockfish, eulachon, anchovy, sardine, herring, smelt, lamprey, and flatfish. Salmon either in the adult or juvenile stages are not known to be the primary prey item for any of these species. For most areas of co-occurrence of pinniped and salmonid populations, there is insufficient information to determine whether pinnipeds are currently having a significant effect on the salmon populations (Council 1999a). However, the take of salmon by pinnipeds and other marine mammals is considered to be part of the estimate for natural mortality. The ability to determine the amount of salmon taken by marine mammals is beyond the scope of this FPEIS. The estimates of natural mortality used in the fishery management process are based on best professional judgment.

Marine mammal interactions with salmon fisheries occur when fishing vessels approach marine mammals, marine mammals prey on hooked salmon and, very rarely, when marine mammals become snagged or entangled in fishing gear. Under Section 118 of the MMPA, commercial fisheries must be classified in one of three categories based on the frequency of incidental mortality and serious injury of marine mammals. The commercial troll fishery off the coasts of Washington, Oregon, and California is classified as a Category III fishery, indicating a remote or no likelihood of known incidental mortality or serious injury of marine mammals. In general, recreational fishery uses the same gear and techniques as the commercial fisheries and can be assumed to have similar rates of encounters and results.

After excluding ESA listed marine mammals, only three species of marine mammals are defined as strategic under MMPA within the coverage area: short-finned pilot whales, mesoplodont beaked whales, and Minke whales (Barlow et al. 1997). This strategic classification denotes that projected human-caused mortality exceeds the species' annual potential biological removal estimate under MMPA standards. As with ESA listed marine mammal species, there is no record of these three species being affected by the ocean salmon fisheries managed by the Council (Council 1999a).

Alternative 2—Mark-Selective Fisheries and Alternative 3—No Incidental Take

Under Alternative 2, effects on mammalian species would be the same as under Alternative 1. Effects from Alternative 3 would include a decrease in fishery-related infractions; localized, short-term increases in the availability of salmon to predators; and an increase in predation on salmon prey species caused by the decline in harvest.

4.3.1.8 Listed Marine Mammals

Alternative 1—No Action

Steller sea lion interaction with the Pacific Coast salmon fisheries is rare and NMFS has determined mortality and serious injury incidental to commercial fishing operations would have a negligible effect (60 FR 45399; August 31, 1995).[6] Available information indicates that Pacific Coast salmon fisheries are not likely to jeopardize the existence of the

[6] A negligible effect is defined as an effect resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through an effect on annual rates of recruitment or survival. Section 7 consultation was completed on this determination (NMFS 1995b) including issuance of an ITS for commercial fishing operations of up to 106 Steller sea lions from the eastern population annually (east of 144° W longitude).

Guadalupe fur seal.[7] No sea turtles have been reported taken by the ocean salmon fisheries off Washington, Oregon, or California. NMFS has determined that commercial fishing by Pacific Coast fisheries would pose a negligible threat to the Pacific species (NMFS 1990).

Salmon are not among the primary prey items for listed cetaceans. Salmon taken in the fisheries are larger than those that might typically be preyed on by the cetaceans; therefore, Pacific Coast fisheries do not compete with cetaceans for food. Fish ingested by the large baleen whales eat almost exclusively small schooling fish such as capelin, herring, and eulachon, or juvenile pollock, cod, and atka mackerel (Perez and McAllister 1998). It is not known to what degree salmon and whales compete for prey or if either population is, as a result, limited. Salmon fishing may occur in locations frequented by migrating or feeding cetaceans. Vessels and operators have occasional interactions with cetaceans but any possible adverse effect on these species is minimized. Interactions are largely mitigated through NMFS-sponsored education programs sensitizing harvesters to marine mammal protection laws and providing approach and watching guidance. Harassment of marine mammals is against the law and violators are prosecuted individually as opposed to holding the entire fishery accountable for the conduct of an individual fisher (Council 1999a).

Alternative 2—Mark-Selective Fisheries and Alternative 3—No Incidental Take

Because Alternative 2 would require no change in fishing method or gear relative to Alternative 1, any difference in effects on mammals would be related to changes in fishing effort and would likely be undetectable. Effects under Alternative 3 would include a decrease in fishery-related interactions, and an increase in predation on salmon prey species caused by a decline in harvest.

4.3.1.9 Listed and Unlisted Avian Species

Alternative 1—No Action

Short-term effects of fishing activity on seabirds include mortality from collisions with vessels and entanglement with fishing gear. Long-term effects include competition with fisheries for prey, alteration of the food web dynamics caused by commercial fishing removals, disruption of avian feeding habits resulting from developed dependence on fishery waste, and fish-waste-related increases in gull populations that prey on other bird species.

Short-term effects on seabirds are minimal, if any. The types of vessels used in the fishery and the conduct of the vessels are not conducive to collisions or the introduction of rats or other non-indigenous species to seabird breeding colonies. Anecdotal information suggests accidental bird encounters are a rare event for commercial and recreational ocean salmon fisheries (Council 1999a). Long-term effects on seabirds from the ocean salmon fisheries are also minimal. The salmon harvested in the fishery are larger than forage fish harvested by seabirds. Salmon troll fishing is not known to provide significant waste and offal to

[7] The primary range for the Guadalupe fur seal is south of the United States/Mexico border; only a few Guadalupe fur seals are known to inhabit rookeries in the Channel Islands (Stewart et al. 1987). There is no record of any Guadalupe fur seal being killed or injured by ocean salmon fishing activity. The total United States fishing mortality and serious injury for this stock is less than 10 percent of the calculated potential biological removal under MMPA standards and can be considered to be insignificant and approaching zero mortality and serious injury rate (Barlow et al. 1997).

attract scavenging birds, but fish processing does provide food directly to scavenging species such as Northern Fulmars and large gulls. This can benefit populations of some species but it can be detrimental to others, which they may displace or prey upon (Furness and Ainley 1984). The amount of salmon waste generated by the fish processing industry is minor. This potential effect is site specific and is assumed not to represent a significant threat to the overall abundance and diversity of the seabird population along the Pacific Coast. No adverse effects by the salmon fisheries have been identified under Alternative 1 (Council 1999a).

Alternative 2—Mark-Selective Fisheries and Alternative 3—No Incidental Take
Because Alternative 2 would require no change in fishing method or gear relative to Alternative 1, any difference in effects on avian species would be related to changes in fishing effort and would likely be undetectable. Under Alternative 3 fisheries would be closed and the limited interactions that do occur would be eliminated. Gear interactions, to the degree that they do occur, would be eliminated. Salmon waste from processing at localized sites would also no longer be available to avian species.

4.3.1.10 Lower Trophic-level Species (Forage Fishes)

Alternative 1—No Action
Effects of fishing activity on lower trophic-level species occur through the alteration of the food web dynamics caused by fishery removals. Marine ecosystems in the central north Pacific Ocean are complex webs of predator/prey relationships. Because the status of each component stock may change annually, predator/prey relationships are also expected to vary. All harvest activities remove animals that otherwise would have remained in the ecosystem where they would prey on other animals and/or would be preyed upon. The removal of adult salmon by the ocean fisheries is not considered to significantly affect the lower trophic levels or the overall marine ecosystem because salmon are not the only or primary predator in the marine environment.

Alternative 2—Mark-Selective Fisheries and Alternative 3—No Incidental Take
Because Alternative 2 proposes no changes in fishing method or gear, and relatively small changes in over catch relative to Alternative 1, the change in interactions with lower trophic species would be negligible. The effect of Alternative 3 on the overall food web is difficult to assess because of its dynamic nature, and our incomplete understanding of contribution of salmon.

4.3.2 Effects on the Human Environment

This section presents an assessment of the economic and social effects for the proposed alternatives. Economic effects, including social welfare and regional economic effects, are described separately for each of the alternatives, followed by a more general discussion of the implications of economic effects for the commercial and recreational fishing communities, the port communities, and surrounding counties. Under each alternative, effects are described for higher chinook abundance conditions from 1988 to 1996 (Baseline 1) and for lower chinook abundance conditions from 1994 to 1997 (Baseline 2).

Potential social welfare effects associated with ocean sport fishing for salmon and commercial troll fishing for salmon are described. Regional economic effects, as represented by personal income effects on the local economy generated by ocean sport fishing and commercial troll fishing, are identified. These analyses are based on results of fishery modeling described in the previous section. For the economic analysis, the two key outputs of the fishery model are harvest and angler effort. When viewing the results of the economic analysis it is important to remember that, even in the case of Alternative 1—No Action, harvest and fishing effort are calculated by using a fishery model and differ from observed historical values. Model-generated values are compared to observed historical values, where appropriate, to provide a context for their interpretation.

4.3.2.1 Analytical Methods

Ideally, the economic analysis would evaluate differential effects of the management alternatives over time, including an assessment of the effects on stock rebuilding and the potential benefits of easing harvest restrictions associated with species listings. This type of analysis also would consider the opportunity costs associated with using resources to harvest the available stocks, and economic effects would be evaluated "at the margin." Because of limited data and many factors other than harvest management affect stock rebuilding, this type of dynamic analysis was not possible for this FPEIS. Alternatively, this assessment focuses on potential effects on commercial and recreational fisheries associated with short-term changes in harvest practices. Average conditions during periods of both higher and lower abundance (Baselines 1 and 2, respectively) are considered to present some of the variability inherent in this type of "static" analysis. Potential economic and social benefits associated with moving toward recovery over the long-term are discussed in Section 4.6, Cumulative Effects.

The discussions of economic effects associated with ocean sport fishing and commercial troll fishing for salmon for each alternative are separated into effects on the sum of net economic benefits produced by the national economy (i.e., social welfare effects) and effects on the distribution of net benefits among identifiable components of society. When reviewing these effects it is important to note the following:

- Alternative 1—No Action: Because Alternative 1 serves as the baseline for the alternatives analysis, economic effects are described but are not compared to other baseline conditions or alternatives. Changes in economic effects from implementing the alternatives compared to Alternative 1 are described in subsequent sections.
- Alternative 2—Mark-Selective Fisheries: Under Alternative 2, two options are evaluated. Option A embodies a less restrictive approach to implementing mark-selective fisheries, whereas Option B is more restrictive. Effects of this alternative and the options are compared to Alternative 1 for Baselines 1 and 2. Details of the methodology for estimating the economic effects are described in Appendix D. In addition to affecting ocean sport and commercial fishing for salmon, Alternative 2 would affect opportunities and associated economics of sport fishing for salmon in inland waters. Implementation of Alternative 2 is expected to change the escapement of naturally reproducing and hatchery salmon to upstream watersheds. In most watersheds Alternative 2 would reduce escapement compared to

Alternative 1 by increasing ocean harvest of hatchery fish. The major exception is the Sacramento-San Joaquin River system in California. The increase in the number of returning naturally producing salmon would offset reduction in the escapement of hatchery-reared salmon and create potential fishing opportunities. Higher catch-per-unit-effort could be expected, which would generate additional angler benefits and potential increases in net income to fishing-related businesses.

- Alternative 3—No Incidental Take: Although Alternative 3 would have adverse effects on economies relying on ocean commercial and sport fishing, it could improve opportunities and associated economics of sport fishing for salmon in inland waters. Implementation of Alternative 3 is expected to increase escapement to upstream watersheds, thereby increasing fishing opportunities. In addition to the potential expansion of inland fisheries, higher catch-per-unit-effort rates can be expected to benefit all affected watersheds, which would generate additional benefits and potential increases in net income to fishing-related businesses.

One kind of distributional effect is estimated by a regional economic analysis. This approach is used to estimate the expected changes in economic activity within a specific geographic region resulting from the adoption of specific alternatives. The region is specified to cover the area where changes are expected to be concentrated. From the society-as-a-whole perspective, partially offsetting changes occurs outside the specified region, but they are not included in this analysis.

For the purposes of this analysis, the economic parameter used to evaluate the social welfare effects of changes in ocean sport fishing for salmon is angler benefits (i.e., net WTP for ocean salmon fishing). For commercial troll fishing for salmon, the parameter used to evaluate social welfare effects is the net income (profit) to commercial troll fishers associated with changes in the ex-vessel value of the salmon harvested, including chinook, coho, sockeye, chum, and pink salmon. This net income approximates producer surplus and nets out operating costs, which are measured by the opportunity costs of resources being diverted into the fish production process. As discussed in Appendix D, changes in the commercial harvest of salmon are also expected to have consumer surplus effects but these effects could not be reliably quantified for this analysis. The parameters used to measure distributional effects from changes in ocean sport and troll fishing for salmon are the direct personal income contribution to the commercial fishing industry and to businesses that sell goods and services to sport anglers within specific boroughs, and changes in net income to businesses that are directly affected by angler activity.

The details of the methodology employed to estimate economic effects within the Council management area are described in Appendix D. The following sections summarize this methodology.

Social Welfare Effects

Ocean Sport Fishing for Salmon

The number of sport fishing trips by port area was estimated using a spreadsheet model developed from Council data. The spreadsheet model predicts the number of sport fishing trips out of each port area based on the number of days that the salmon season is assumed open for sport fishing and on the timing of the open season. Observed data on catch per unit of effort and catch levels for the two baselines were used in the spreadsheet model to estimate effort. This information was used to quantify sport fishing-related expenditures by anglers, net income to sport fishing-related businesses from salmon fishing, and net benefits to ocean salmon anglers.

The net benefits to ocean salmon anglers, as measured by their net WTP for salmon fishing opportunities, were estimated based on average per trip values for sport fishing for salmon by harvest area, as reported by Thomson and Huppert (1987). From this study, an average value of $70 per trip (in 1996 dollars) for sport fishing for salmon from private boats and charterboats was derived and applied to the predicted number of trips.

Commercial Troll Fishing for Salmon

The chinook and coho harvest and ex-vessel value by alternative was estimated for the 14 port areas along the Pacific Coast using a spreadsheet model developed from Council data. The spreadsheet model, which is described in Appendix E, incorporates assumptions about the number of days that the season is open for a particular species and the timing of these openings. Observed data on harvest per unit of effort and level of effort for the two baselines were used to estimate harvest. Modeling results were then used to estimate net income (profits) to commercial salmon fishers by port area.

A net income coefficient of 0.40, derived from proprietary income data for Pacific Coast regions in the 1992 IMPLAN database, was applied to predicted ex-vessel revenues for each port area to arrive at net income (refer to Appendix D for a comparison of net income coefficients employed by other fishery economic studies).

Distributional Effects

Ocean Sport Fishing for Salmon

Total (direct, indirect, and induced) personal income generated by salmon angler spending was estimated based on personal income multipliers for major port areas applied to the predicted number of sport fishing trips for salmon. These multipliers, which generate personal income estimates for counties within the major port areas, were obtained from the Council (Seger personal communication). The multipliers were originally derived from information compiled for the Fishery Economic Assessment Model (Radtke, et al. 1986). The analytical procedures used to estimate total personal income effects do not differentiate between spending by resident and nonresident anglers. From a local or regional economic effect perspective, this distinction is important because spending by anglers who live outside the region of interest represents "new" income to the region, whereas spending by residents of the region is primarily income that is re-directed from other activities within the region. This distinction could not be accurately accounted for in the analysis because of limited data on the relative proportion of resident and nonresident anglers and on spending patterns of resident anglers. The effect on the analysis of not accounting for this is that the estimates of changes in direct personal income are overstated, probably by 20 to 30 percent.

Angler spending on sport fishing for salmon in the Pacific Coast port areas was estimated based on spending profiles developed from a 1991 study by The Research Group on sport fishing activity in Oregon. A per-angler-day spending estimate of $71.52 (in 1996 dollars) was derived by averaging spending profiles for resident and nonresident anglers. The per-day spending profiles were multiplied by the predicted salmon angler trips to estimate total spending associated with sport fishing for salmon. The net income received by affected sport fishing-related businesses was estimated based on a net income coefficient of 0.116, which was derived from data on proprietary income in the 1992 IMPLAN database. This coefficient was applied to estimated sport fishing-related spending to estimate net income for affected businesses (refer to Appendix D for more discussion of how the net income coefficient was derived).

Commercial Troll Fishing For Salmon

Total (direct, indirect, and induced) personal income generated by commercial fishing for salmon was estimated based on personal income multipliers applied to the estimated ex-vessel value of the chinook and coho harvest. These multipliers, which produce personal income estimates for counties within and, in certain cases, adjacent to major port areas, were obtained from the Council. The multipliers were originally derived from information compiled for the Fishery Economic Assessment Model (Radtke, et al. 1986). Because the personal income multipliers were derived for geographic areas larger than some of the major port areas, changes in fishing activity in adjacent port areas may affect the same counties. For example, the multipliers used to measure personal income changes resulting from changes in harvests in the Coos Bay and Brookings port areas affect the same four counties (i.e., Lane, Douglas, Coos, and Curry counties), although effects would likely be largest in communities within the port areas that are directly affected.

The income effects on processors are included in the estimates of local income effects. The percentage of local income attributable to processors varies by location, species harvested, and type of gear used for harvesting. Based on information from the Fishery Economic Assessment Model developed by The Research Group, processors account for about 25 percent of the local income generated by troll fishing for chinook, about 65 percent of the local income generated by net fishing for coho, and about 85 percent of the local income generated by net fishing for chinook.

4.3.2.2 Social Welfare Effects

Ocean Sport Fishing for Salmon

Alternative 1—No Action

The analysis of ocean sport fishing for salmon focuses on social welfare effects associated with predicted angler trips. The economic parameters used to evaluate these effects include angler benefits (i.e., net WTP for ocean salmon fishing) and net income (profit) to businesses that are directly affected by angler activity. The types of businesses that would be affected include charter boat and marina operations, lodging, food and beverage establishments, food stores, service stations, and other miscellaneous retail businesses.

The number of predicted angler trips for salmon, including private and charter boat trips, under Alternative 1 is shown in Table 4.3-9 for Baseline 1. As shown, ports in the State of Washington, would account for approximately 39,500 angler trips and $2.8 million in angler benefits, or approximately 16 percent of salmon angler trips and benefits within the region. Oregon ports would account for approximately 35 percent of regionwide trips and benefits and California ports would account for approximately 49 percent of the total. In the State of Washington ports in the Grays Harbor area account for approximately

45 percent of statewide angler trips and benefits. Newport is the most important port area for salmon in Oregon, accounting for approximately 36 percent of angler trips and benefits. Ports in the San Francisco area account for nearly 52 percent of all salmon angler trips and benefits in California.

For Baseline 2, predicted angler trips and angler benefits are shown in Table 4.3-10. In general, the abundance of salmon decreases as compared to Baseline 1; however, fishing effort for Baseline 2 would increase in areas where effort is not constrained by potential effects to listed species, such as fishing areas south of the KMZ. Regionwide, the number of angler trips for salmon is predicted to increase by approximately 13,600 trips (6 percent) compared to Baseline 1. Angler trips and benefits at California ports south of the KMZ would increase by 74,000 trips and $5.2 million, respectively; angler activity and benefits at all other Pacific Coast ports are predicted to decrease.

Alternative 2—Mark-Selective Fisheries, Option A

The number of predicted angler trips for salmon, including private and charter boat trips, under Alternative 2, Option A is shown in Table 4.3-9 for Baseline 1. As shown, ports in the State of Washington would account for 124,250 angler trips for salmon and $8.7 million in angler benefits, or 25 percent of salmon angler trips and benefits regionwide compared to 16 percent under Alternative 1. Angler trips and benefits are predicted to increase by more than 200 percent compared to Alternative 1. Anglers fishing for salmon out of Columbia River-Washington would receive an estimated $2.6 million in benefits and anglers fishing for salmon out of Grays Harbor would receive approximately $3.9 million in benefits.

Oregon ports would account for approximately 212,000 angler trips and $14.8 million in angler benefits, or 42 percent of regionwide trips and benefits compared to 35 percent under Alternative 1. Angler trips and benefits are predicted to increase by more than 100 percent at ports north of the KMZ and by approximately 460 percent in Broodings compared to Alternative 1. Although anglers fishing for salmon out of Newport are expected to take the most trips (and receive the most benefits overall), the largest change in angler trips and benefits would occur at Brookings, where salmon anglers are expected to take an additional 34,700 trips annually and receive an additional $2.4 million in benefits.

California ports would account for approximately 167,300 angler trips and $11.7 million in angler benefits, or 33 percent of regionwide trips and benefits compared to 49 percent under Alternative 1. Angler trips and benefits are predicted to increase by an estimated 460 percent at ports within the KMZ (Crescent City and Eureka) but be similar to conditions under Alternative 1 for ports south of the KMZ. Anglers fishing for salmon out of San Francisco and Monterey would continue to take the majority of angler trips and receive most of the regionwide benefits associated with salmon fishing.

For Baseline 2, predicted angler trips and angler benefits for Alternative 2, Option A are shown in Table 4.3-10. Regionwide, angler benefits would increase by $19.7 million, an increase of 108 percent from Alternative 1. In Washington the increase in angler benefits would range from 329 percent (Columbia River-Washington) to nearly 500 percent (Grays Harbor). In Oregon angler benefits would increase approximately 275 percent at

Table 4.3-9. Net economic values for sport fishing in the Council management area under Alternatives 1 and 2 for Baseline 1.

	Alternative 1			Alternative 2, Option A							Alternative 2, Option B						
					Angler Benefits[1/]			Net Income to Businesses[1/]				Angler Benefits[1/]			Net Income to Businesses[1/]		
Ports	**Angler Trips**	**Angler Benefits**	**Net Income to Businesses**	**Angler Trips**	**Value**	**Change**	**% Change**	**Value**	**Change**	**% Change**	**Angler Trips**	**Value**	**Change**	**% Change**	**Value**	**Change**	**% Change**
Washington Ports																	
Neah Bay	9,060	$634,200	$75,165	28,503	$1,995,210	$1,361,010	215	$236,470	$161,305	215	9,060	$634,200	$0	0	$75,165	$0	0
La Push	953	$66,710	$7,906	2,998	$209,860	$143,150	215	$24,872	$16,966	215	953	$66,710	$0	0	$7,906	$0	0
Grays Harbor	17,635	$1,234,450	$146,306	55,482	$3,883,740	$2,649,290	215	$460,296	$313,990	215	17,635	$1,234,450	$0	0	$146,306	$0	0
Columbia River	11,845	$829,150	$98,270	37,267	$2,608,690	$1,779,540	215	$309,179	$210,909	215	11,845	$829,150	$0	0	$98,270	$0	0
STATE TOTAL	**39,493**	**$2,764,510**	**$327,647**	**124,250**	**$8,697,500**	**$5,932,990**	**215**	**$1,030,817**	**$703,170**	**215**	**39,493**	**$2,764,510**	**$0**	**0**	**$327,647**	**$0**	**0**
Oregon Ports																	
Tillamook	12,685	$887,950	$105,239	25,793	$1,805,510	$917,580	103	$213,987	$108,748	103	12,794	$895,580	$7,630	1	$106,143	$904	1
Newport	30,879	$2,161,530	$256,182	62,789	$4,395,230	$2,233,700	103	$520,918	$264,736	103	31,144	$2,180,080	$18,550	1	$258,381	$2,199	1
Coos Bay	27,691	$1,938,370	$229,733	56,307	$3,941,490	$2,003,120	103	$467,141	$237,408	103	27,929	$1,955,030	$16,660	1	$231,708	$1,975	1
Brookings	7,540	$527,800	$62,554	42,242	$2,956,940	$2,429,140	460	$350,453	$287,899	460	7,540	$527,800	$0	0	$62,554	$0	0
STATE TOTAL	**86,692**	**$6,068,440**	**$719,224**	**211,975**	**$14,838,250**	**$8,769,810**	**145**	**$1,758,613**	**$1,039,389**	**145**	**87,304**	**$6,111,280**	**$42,840**	**1**	**$724,302**	**$5,078**	**1**
California Ports																	
Crescent City	5,173	$362,110	$42,917	28,979	$2,028,530	$1,666,420	460	$240,419	$197,502	460	5,173	$362,110	$0	0	$42,917	$0	0
Eureka	5,152	$360,640	$42,743	28,860	$2,020,200	$1,659,560	460	$239,432	$196,689	460	5,152	$360,640	$0	0	$42,743	$0	0
Fort Bragg	12,526	$876,820	$103,920	12,526	$876,820	$0	0	$103,920	$0	0	12,526	$876,820	$0	0	$103,920	$0	0
San Francisco	61,815	$4,327,050	$512,837	61,815	$4,327,050	$0	0	$512,837	$0	0	61,815	$4,327,050	$0	0	$512,837	$0	0
Monterey	35,137	$2,459,590	$291,508	35,137	$2,459,590	$0	0	$291,508	$0	0	35,137	$2,459,590	$0	0	$291,508	$0	0
STATE TOTAL	**119,803**	**$8,386,210**	**$993,925**	**167,317**	**$11,712,190**	**$3,325,980**	**40**	**$1,388,116**	**$394,191**	**40**	**119,803**	**$8,386,210**	**$0**	**0**	**$993,925**	**$0**	**0**
REGION TOTAL	**245,988**	**$17,219,160**	**$2,040,796**	**503,542**	**$35,247,940**	**$18,028,780**	**105**	**$4,177,546**	**$2,136,750**	**105**	**246,600**	**$17,262,000**	**$42,840**	**0**	**$2,045,874**	**$5,078**	**0**

Notes:
[1/] Change and % change for angler benefits and net income to businesses are in relation to Alternative 1—No Action.
Angler benefits are estimated based on an average value of $70 per trip, as derived by Thomson and Huppert (1987).
Net income to businesses is estimated at 11.6 percent of angler spending and was derived from information on proprietary income from IMPLAN. A weighted (based on proportionate spending) average from the following sectors was used: food stores, eating and drinking establishments, service stations and fuel, hotels and motels, and miscellaneous retail trade.
All monetary values are in constant 1996 dollars.
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

Table 4.3-10. Net economic values for sport fishing in the Council management area under Alternatives 1 and 2 for Baseline 2.

Ports	Alternative 1			Alternative 2, Option A							Alternative 2, Option B						
					Angler Benefits[1/]			Net Income to Businesses[1/]				Angler Benefits[1/]			Net Income to Businesses[1/]		
	Angler Trips	Angler Benefits	Net Income to Businesses	Angler Trips	Value	Change	% Change	Value	Change	% Change	Angler Trips	Value	Change	% Change	Value	Change	% Change
Washington Ports																	
Neah Bay	4,372	$306,040	$36,272	24,825	$1,737,750	$1,431,710	468	$205,956	$169,684	468	5,512	$385,840	$79,800	26	$45,729	$9,457	26
La Push	584	$40,880	$4,845	2,611	$182,770	$141,890	347	$21,662	$16,817	347	580	$40,600	($280)	(1)	$4,812	($33)	(1)
Grays Harbor	8,073	$565,110	$66,976	48,323	$3,382,610	$2,817,500	499	$400,903	$333,927	499	10,728	$750,960	$185,850	33	$89,003	$22,027	33
Columbia River-Washington	7,558	$529,060	$62,704	32,458	$2,272,060	$1,743,000	329	$269,282	$206,578	329	7,206	$504,420	($24,640)	(5)	$59,783	($2,921)	(5)
STATE TOTAL	**20,587**	**$1,441,090**	**$170,797**	**108,217**	**$7,575,190**	**$6,134,100**	**426**	**$897,803**	**$727,006**	**426**	**24,026**	**$1,681,820**	**$240,730**	**17**	**$199,327**	**$28,530**	**17**
Oregon Ports																	
Columbia River-Oregon	5,039	$352,730	$41,805	21,639	$1,514,730	$1,162,000	329	$179,524	$137,719	329	4,804	$336,280	($16,450)	(5)	$39,856	($1,949)	(5)
Tillamook	6,993	$489,510	$58,016	25,793	$1,805,510	$1,316,000	269	$213,987	$155,971	269	9,079	$635,530	$146,020	30	$75,322	$17,306	30
Newport	17,023	$1,191,610	$141,228	62,789	$4,395,230	$3,203,620	269	$520,918	#379,690	269	22,101	$1,547,070	$355,460	30	$183,357	$42,129	30
Coos Bay	15,266	$1,068,620	$126,652	56,307	$3,941,490	$2,872,870	269	$467,141	$340,489	269	19,819	$1,387,330	$318,710	30	$164,425	$37,773	30
Brookings	4,717	$330,190	$39,134	35,022	$2,451,540	$2,121,350	642	$290,554	$251,420	642	4,717	$330,190	$0	0	$39,134	$0	0
STATE TOTAL	**49,038**	**3,432,660**	**406,835**	**201,550**	**14,108,500**	**$10,675,840**	**311**	**$1,672,124**	**$1,265,289**	**311**	**60,520**	**$4,236,400**	**$803,740**	**$803,740**	**502,094**	**$95,259**	**23**
California Ports																	
Crescent City	3,236	$226,520	$26,847	24,026	$1,681,820	$1,455,300	642	$199,327	$172,480	642	3,236	$226,520	$0	0	$26,847	$0	0
Eureka	3,223	$225,610	$26,739	23,928	$1,674,960	$1,449,350	642	$198,514	$171,775	642	3,223	$225,610	$0	0	$26,739	$0	0
Fort Bragg	20,994	$1,469,580	$174,173	20,994	$1,469,580	$0	0	$174,173	$0	0	20,994	$1,469,580	$0	0	$174,173	$0	0
San Francisco	103,605	$7,252,350	$859,540	103,605	$7,252,350	$0	0	$859,540	$0	0	103,605	$7,252,350	$0	0	$859,540	$0	0
Monterey	58,892	$4,122,440	$488,587	58,892	$4,122,440	$0	0	$488,587	$0	0	58,892	$4,122,440	$0	0	$488,587	$0	0
STATE TOTAL	**189,950**	**$13,296,500**	**$1,575,886**	**231,445**	**$16,201,150**	**$2,904,650**	**22**	**$1,920,141**	**$344,255**	**22**	**189,950**	**$13,296,500**	**$0**	**0**	**$1,575,886**	**$0**	**0**
REGION TOTAL	**259,575**	**$18,170,250**	**$2,153,518**	**541,212**	**$37,884,840**	**$19,174,590**	**108**	**$4,490,068**	**$2,336,550**	**108**	**274,496**	**$19,214,720**	**$1,044,470**	**6**	**$2,227,307**	**$123,789**	**6**

Notes:
[1/] Change and % change for angler benefits and net income to businesses are in relation to Alternative 1—No Action.
Angler benefits are estimated based on an average value of $70 per trip, as derived by Thomson and Huppert (1987).
Net income to businesses is estimated at 11.6 percent of angler spending and was derived from information on proprietary income from IMPLAN. A weighted (based on proportionate spending) average from the following sectors was used: food stores, food and beverage establishments, service stations and fuel, hotels and motels, and miscellaneous retail trade.
All monetary values are in constant 1996 dollars.
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

ports north of the KMZ and more than 640 percent at Brookings. In California angler benefits would also increase approximately 640 percent at Crescent City and Eureka, but remain similar to conditions under Alternative 1 for port areas south of the KMZ.

Alternative 2—Mark-Selective Fisheries, Option B

As shown in Table 4.3-9, the number of predicted angler trips and benefits associated with sport fishing for salmon under Alternative 2, Option B for Baseline 1 is similar to the Alternative 1. Ports in Washington would account for approximately 39,500 angler trips for salmon and $2.8 million in angler benefits, or 16 percent of salmon angler trips and benefits regionwide. Oregon ports would account for approximately 87,300 angler trips and $6.1 million in angler benefits, or 35 percent of regionwide trips and benefits. California ports would account for approximately 119,800 angler trips and $8.4 million in angler benefits, or 49 percent of regionwide trips and benefits.

For Baseline 2, predicted angler trips and angler benefits for Alternative 2, Option B are shown in Table 4.3-10. Regionwide, angler benefits would increase by approximately $1.0 million (6 percent). This increase would result entirely from increased sport fishing effort at five Oregon and Washington ports north of the KMZ. Increases in angler trips and benefits in Washington would occur at Neah Bay and Grays Harbor, but the trips would be offset by decreases at the Columbia River-Washington port. In Oregon increases in trips and benefits would occur in Tillamook, Newport, and Coos Bay, but would decrease at the Columbia River-Oregon port. There would be no change in angler effort or benefits in port areas from the KMZ and south.

Alternative 3—No Incidental Take

Under Alternative 3, there would be no sport fishing for salmon in coastal waters. The effect of this alternative would be to forego the social welfare effects of ocean sport fishing for salmon generated under Alternative 1. These effects are shown in Table 4.3-9 for Baseline 1 and Table 4.3-10 for Baseline 2.

Under Alternative 3 (Baseline 1), anglers would forego the benefits associated with ocean sport fishing for salmon under Alternative 1, which are estimated regionwide to be $17.2 million based on 246,000 angler trips (Table 4.3-9). Anglers from Washington, Oregon, and California ports would forego approximately $2.8 million, $6.1 million, and $8.4 million in annual benefits, respectively. Annual benefits foregone include $4.3 million and $2.5 million by salmon anglers from San Francisco and Monterey, California, respectively; and approximately $2.2 million by anglers from Newport, Oregon. Sport fishing for salmon in inland waters or fishing for marine species other than salmon may recapture some of the foregone angler benefits.

For Baseline 2, anglers would forego $18.2 million in angler benefits, just as under Alternative 1. Washington, Oregon, and California anglers would forego approximately $1.4 million, $3.4 million, and $13.3 million in annual benefits, respectively (Table 4.3-10). As indicated above, some of the foregone angler benefits may be recaptured by sport fishing for salmon in inland waters or by sport fishing for marine species other than salmon.

Commercial Troll Fishing for Salmon

Alternative 1—No Action

The analysis of commercial troll fishing for salmon focuses on the social welfare effects associated with the ex-vessel value of the salmon harvest, including chinook and coho salmon. The economic parameter used to evaluate these effects is the net income (profit) to commercial fishers. As indicated above, changes in consumer surplus could not be quantified for the analysis but are discussed in Appendix D.

The ex-vessel value and net income to commercial fishers from troll-caught chinook and coho salmon under Alternative 1 is shown in Table 4.3-11 for Baseline 1. As shown, ports in the State of Washington would account for a small (less than 1 percent) share of the regionwide harvest value and net income to commercial fishers. Oregon ports would account for approximately 19 percent of regionwide harvest and net income and California ports would account for the remaining 80 percent of harvest value, which would total an estimated $7.0 million in annual net income regionwide to commercial fishers. Coos Bay is the most important commercial salmon port in Oregon, accounting for approximately 33 percent of the ex-vessel value and net income generated by the salmon troll fishery under Alternative 1. Ports in the San Francisco area account for approximately 50 percent of the ex-vessel value and net income generated by the salmon troll fishery in California.

Table 4.3-12 shows ex-vessel value and net income to commercial fishers for Baseline 2, when the abundance of salmon available for commercial harvest was lower in most port areas compared to Baseline 1. Port areas where the ex-vessel value and net income to commercial salmon fishers was higher (relative to Baseline 1) include Neah Bay and Grays Harbor. Regionwide, the net income to commercial salmon fishers generated by troll-caught salmon is estimated to be approximately $645,600 (9 percent) lower compared to Baseline 1.

Alternative 2—Mark-Selective Fisheries, Option A

The ex-vessel value of troll-caught chinook and coho salmon. Alternative 2, Option A is shown in Table 4.3-11 for Baseline 1. The ex-vessel value and net income to commercial salmon fishers in the State of Washington would be approximately $802,000 and $321,000, respectively, which accounts for approximately 5 percent of the regionwide totals compared to less than 1 percent under Alternative 1. Statewide, the ex-vessel value and net income to commercial salmon fishers would increase by 836 percent. The largest change in net income to commercial salmon fishers would occur at Neah Bay (approximately $136,000), with the largest percentage increase (1,175 percent) occurring in Columbia River-Washington.

Table 4.3-11. Net income for commercial fishing in the Council management area under Alternatives 1 and 2 for Baseline 1.

Ports	Alternative 1		Alternative 2, Option A				Alternative 2, Option B			
				Net Income to Commercial Fishers				Net Income to Commercial Fishers		
	Ex-Vessel Value	Net Income to Commercial Fishers	Ex-Vessel Value	Value	Change[1/]	% Change[1/]	Ex-Vessel Value	Value	Change[1/]	% Change[1/]
Washington Ports										
Neah Bay	$30,700	$12,280	$295,000	$118,000	$105,720	861	$27,800	$11,120	-$1,160	(9)
La Push	$9,300	$3,720	$84,000	$33,600	$29,880	803	$7,600	$3,040	($680)	(18)
Grays Harbor	$41,400	$16,560	$368,200	$147,280	$130,720	789	$33,000	$13,200	($3,360)	(20)
Columbia River-Washington	$4,320	$1,728	$55,020	$22,008	$20,280	1,174	$6,000	$2,400	$672	39
STATE TOTAL	**$85,720**	**$34,288**	**$802,220**	**$320,888**	**$286,600**	**836**	**$74,400**	**$29,760**	**($4,528)**	**(13)**
Oregon Ports										
Columbia River-Oregon	$2,880	$1,152	$36,680	$14,672	$13,520	1,174	$4,000	$1,600	$448	39
Tillamook	$262,900	$105,160	$570,100	$228,040	$122,880	117	$235,600	$94,240	($10,920)	(10)
Newport	$1,117,400	$446,960	$1,674,000	$669,600	$222,640	50	$1,052,200	$420,880	($26,080)	(6)
Coos Bay	$1,936,800	$774,720	$2,653,900	$1,061,560	$286,840	37	$1,759,500	$703,800	($70,920)	(9)
Brookings	$94,200	$37,680	$169,000	$67,600	$29,920	79	$68,200	$27,280	($10,400)	(28)
STATE TOTAL	**$3,414,180**	**$1,365,672**	**$5,103,680**	**$2,041,472**	**$675,800**	**49**	**$3,119,500**	**$1,247,800**	**($117,872)**	**(9)**
California Ports										
Crescent City	$39,800	$15,920	$71,400	$28,560	$12,640	79	$28,800	$11,520	($4,400)	(28)
Eureka	$125,700	$50,280	$225,400	$90,160	$39,880	79	$91,000	$36,400	($13,880)	(28)
Fort Bragg	$3,322,400	$1,328,960	$2,480,600	$992,240	($336,720)	(25)	$2,480,600	$992,240	($336,720)	(25)
San Francisco	$7,105,600	$2,842,240	$5,305,300	$2,122,120	($720,120)	(25)	$5,305,300	$2,122,120	($720,120)	(25)
Monterey	$3,422,500	$1,369,000	$2,555,300	$1,022,120	($346,880)	(25)	$2,555,300	$1,022,120	($346,880)	(25)
Santa Barbara	$106,800	$42,720	$79,800	$31,920	($10,800)	(25)	$79,800	$31,920	($10,800)	(25)
STATE TOTAL	$14,122,800	$5,649,120	$10,717,800	$4,287,120	($1,362,000)	(24)	$10,540,800	$4,216,320	($1,432,800)	(25)
REGION TOTAL	**$17,622,700**	**$7,049,080**	**$16,623,700**	**$6,649,480**	**($399,600)**	**(6)**	**$13,734,700**	**$5,493,880**	**($1,555,200)**	**(22)**

Notes:
1/ Change and % change for angler benefits and net income to businesses are in relation to Alternative 1—No Action.
Net income to commercial fishers is estimated at 40 percent of the ex-vessel value based on information from IMPLAN on proprietary income as a percentage of ex-vessel value for the commercial fishing sector.
All monetary values are in constant 1996 dollars.
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

Table 4.3-12. Net income for commercial fishing in the Council management area under Alternatives 1 and 2 for Baseline 2.

	Alternative 1		Alternative 2, Option A				Alternative 2, Option B			
				Net Income to Commercial Fishers				Net Income to Commercial Fishers		
	Ex-Vessel Value	Net Income to Commercial Fishers	Ex-Vessel Value	Value	Change[1/]	% Change[1/]	Ex-Vessel Value	Value	Change[1/]	% Change[1/]
Washington Ports										
Neah Bay	$115,300	$46,120	$105,400	$42,160	($3,960)	(9)	$56,800	$22,720	($23,400)	(51)
La Push	$6,100	$2,440	$31,900	$12,760	$10,320	423	$17,200	$6,880	$4,440	182
Grays Harbor	$142,200	$56,880	$90,900	$36,360	($20,520)	(36)	$76,700	$30,680	($26,200)	(46)
Columbia River-Washington	$0	$0	$14,820	$5,928	$5,928	NA	$7,980	$3,192	$3,192	NA
STATE TOTAL	**$263,600**	**$105,440**	**$243,020**	**$97,208**	**($8,232)**	**(8)**	**$158,680**	**$63,472**	**($41,968)**	**(40)**
Oregon Ports										
Columbia River-Oregon	$0	$0	$9,880	$3,952	$3,952	NA	$5,320	$2,128	$2,128	NA
Tillamook	$196,200	$78,480	$233,000	$93,200	$14,720	19	$230,000	$92,000	$13,520	17
Newport	$833,800	$333,520	$925,000	$370,000	$36,480	11	$921,000	$368,400	$34,880	10
Coos Bay	$1,445,400	$578,160	$1,584,000	$633,600	$55,440	10	$1,578,000	$631,200	$53,040	9
Brookings	$60,700	$24,280	$107,400	$42,960	$18,680	77	$44,000	$17,600	($6,680)	(28)
STATE TOTAL	**$2,536,100**	**$1,014,440**	**$2,859,280**	**$1,143,712**	**$129,272**	**13**	**$2,778,320**	**$1,111,328**	**$96,888**	**10**
California Ports										
Crescent City	$25,700	$10,280	$45,400	$18,160	$7,880	77	$18,600	$7,440	($2,840)	(28)
Eureka	$80,900	$32,360	$143,300	$57,320	$24,960	77	$58,700	$23,480	($8,880)	(27)
Fort Bragg	$3,118,900	$1,247,560	$2,212,800	$885,120	($362,440)	(29)	$2,329,300	$931,720	($315,840)	(25)
San Francisco	$6,670,400	$2,668,160	$4,732,600	$1,893,040	($775,120)	(29)	$4,981,700	$1,992,680	($675,480)	(25)
Monterey	$3,212,800	$1,285,120	$2,279,500	$911,800	($373,320)	(29)	$2,399,500	$959,800	($325,320)	(25)
Santa Barbara	$100,300	$40,120	$71,200	$28,480	($11,640)	(29)	$74,900	$29,960	($10,160)	(25)
STATE TOTAL	**$13,209,000**	**$5,283,600**	**$9,484,800**	**$3,793,920**	**($1,489,680)**	**(28)**	**$9,862,700**	**$3,945,080**	**($1,338,520)**	**(25)**
REGION TOTAL	**$16,008,700**	**$6,403,480**	**$12,587,100**	**$5,034,840**	**($1,368,640)**	**(21)**	**$12,799,700**	**$5,119,880**	**($1,283,600)**	**(20)**

Notes:
[1/] Change and % change for angler benefits and net income to businesses are in relation to Alternative 1—No Action.
Net income to commercial fishers is estimated at 40 percent of the ex-vessel value based on information from IMPLAN on proprietary income as a percentage of ex-vessel value for the commercial fishing sector.
All monetary values are in constant 1996 dollars.
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

Oregon ports would account for approximately $5.1 million in ex-vessel value and $2.0 million in net income to commercial fishers, or 31 percent of the regionwide totals compared to 19 percent under Alternative 1. Net income to commercial salmon fishers is predicted to increase by an estimated $123,000 (117 percent) at Tillamook, $223,000 (50 percent) at Newport, and by $287,000 (37 percent) at Coos Bay. Net income is predicted to decrease by approximately $30,000 at Brookings as a result of the relative mix of stocks and the associated constraints on harvest.

California ports would account for approximately $10.7 million in ex-vessel value and $4.3 million in net income to commercial salmon fishers, or 64 percent of the regionwide totals compared to 80 percent under Alternative 1. Net income to commercial salmon fishers is predicted to increase by estimated $13,000 (79 percent) at Crescent City and $40,000 (79 percent) at Eureka; however, 25 percent reductions in net income are predicted at ports south of the KMZ as a result of the mark-selective program. Net income to commercial salmon fishers would be reduced by an estimated $337,000 at Fort Bragg, $720,000 at San Francisco, $347,000 at Monterey, and $11,000 at Santa Barbara ports. These losses are likely to be offset to some degree by substituting other species for salmon.

For Baseline 2, the ex-vessel value and net income to commercial salmon fishers under Alternative 2, Option A are shown in Table 4.3-12. Regionwide, the ex-vessel value of the salmon harvest would decrease by approximately $3.4 million and the net income to commercial salmon fishers would decrease by an estimated $1.4 million compared to Alternative 1. This change represents a decrease of approximately 21 percent. For ports in Washington net income would decrease by approximately $8,000 for commercial salmon fishers statewide, although net income would increase at La Push and Columbia River-Washington port communities. In Oregon net income to commercial salmon fishers would increase by approximately $129,000, with the largest increase ($55,000) occurring at Coos Bay. In California increases in net income to commercial salmon fishers are estimated for Crescent City and Eureka; however, these increases would be more than offset by substantial reductions in net income to commercial salmon fishers at ports south of the KMZ. The overall effect on net income to commercial salmon fishers in California is a reduction of $1.5 million.

It should be noted that the estimates of changes in net income presented above do not account for the effect of reduced harvest efficiency associated with the mark-selective program. As described in Appendix D, Alternative 2, Option A assumes the encounter rate for unmarked chinook salmon would range from approximately 23 percent in fishing areas off the Washington coast to approximately 52 percent in the KMZ. Because unmarked fish must be released, the overall efficiency of commercial fishing is reduced. This reduced efficiency, in turn, increases the variable costs (e.g., fuel and supplies) of commercial troll fishing for salmon, thereby reducing potential net income.

For the effects analysis in this FPEIS, it was assumed that 40 percent of the ex-vessel value would be retained as net income by commercial salmon fishers. This percentage was derived from IMPLAN information on proprietary income as a proportion of total income received by commercial fishers in Northern California and Oregon. Based on information from a study on the economic effects of management changes for Kenai River sockeye salmon (Institute of Social and Economic Research 1996), variable costs (including payments to crew) represent approximately 57 percent of the total costs for commercial drift net operations in south-central Alaska. Based on this variable-to-total cost relationship, the reduction in harvest efficiency associated with the mark-selective program for the Council management area could reduce estimated profit margins of commercial salmon fishers from 40 percent to as low as 25 percent.

Alternative 2—Mark-Selective Fisheries, Option B

The ex-vessel value of troll-caught chinook and coho salmon under Alternative 2, Option B is shown in Table 4.3-11 for Baseline 1. The ex-vessel value and net income to commercial salmon fishers in the State of Washington would be $74,000 and $30,000, respectively, accounting for less than 1 percent of the regionwide totals, which is comparable to its share under Alternative 1. Statewide, the ex-vessel value and net income to commercial salmon fishers would decrease by approximately 13 percent. Net income would decrease in the Neah Bay and Grays Harbor port areas but would increase in the Columbia River-Washington port area.

Oregon ports would account for an estimated $3.1 million in ex-vessel value and $1.2 million in net income to commercial fishers, or 23 percent of the regionwide totals compared to 19 percent under Alternative 1. Net income to commercial salmon fishers is predicted to increase by $1,600 (39 percent) in the Columbia River-Oregon port area and to decrease by $26,000 (6 percent) at Newport.

California ports would account for an estimated $10.5 million in ex-vessel value and $4.2 million in net income to commercial salmon fishers, or 77 percent of the regionwide totals compared to 80 percent under Alternative 1. Net income to commercial salmon fishers is predicted to decrease in all California port areas, including those within the KMZ. Decreases would range from $4,400 (28 percent) in Crescent City to $720,000 (25 percent) in San Francisco. These losses are likely to be offset to some degree by substituting other species for salmon.

For Baseline 2, the ex-vessel value and net income to commercial salmon fishers under Alternative 2, Option A are shown in Table 4.3-12. Regionwide, the ex-vessel value of the salmon harvest would decrease by approximately $3.2 million and the net income to commercial salmon fishers would decrease by $1.2 million compared to Alternative 1. This change represents a decrease of approximately 20 percent. For ports in Washington, net income would increase by approximately $3,000 for commercial salmon fishers at Columbia River-Washington but would decrease for commercial salmon fishers at all other ports. The largest decrease in net income to commercial salmon fishers would occur at Grays Harbor, where net income is predicted to decrease by approximately $26,000 annually. In Oregon net income to commercial salmon fishers would increase by $97,000, with the largest increase ($53,000) occurring at Coos Bay. In California decreases in net income to commercial salmon fishers are estimated for all port areas, with reductions ranging from $3,000 in Crescent City to $675,000 in San Francisco. The overall effect on net income to commercial salmon fishers in California is a reduction of $1.3 million.

As described for Alternative 2, Option A, the estimated changes in net income presented above do not account for the effect of reduced harvest efficiency associated with the mark-selective program. The reduction in harvest efficiency associated with the program could reduce estimated profit margins of commercial salmon fishers from 40 percent, which was assumed in the analysis, to as low as 25 percent.

Alternative 3—No Incidental Take

Under Alternative 3, there would be no commercial troll fishing for salmon in coastal waters. The effect of this alternative would be to forego the social welfare effects of commercial troll fishing for salmon generated under Alternative 1, which are shown in Table 4.3-11 for Baseline 1 and Table 4.3-12 for Baseline 2.

Under Alternative 3 (Baseline 1), commercial salmon fishers would forego the net income associated with troll fishing for salmon under Alternative 1, which is estimated regionwide to be $7.0 million based on an ex-vessel value of $17.6 million (Table 4.3-11). Commercial salmon fishers from Washington, Oregon, and California ports would forego approximately $34,000, $1.4 million, and $5.6 million in net income, respectively. Annual net income foregone by commercial salmon fishers from the San Francisco port area would be approximately $2.8 million. Fishing for other species that are available during the salmon season may recapture some of this foregone net income by commercial salmon fishers, but these opportunities are expected to be very limited because of existing quotas on other species.

For Baseline 2, commercial salmon fishers would forego $6.4 million in net income regionwide. Washington, Oregon, and California commercial fishers would forego approximately $105,000, $1.0 million, and $5.3 million in annual net income, respectively (Table 4.3-12). As indicated above, fishing for other species during the salmon season may recapture a small portion of this foregone net income.

Consumers of Salmon

All Alternatives

As discussed in Appendix D, changes in the commercial harvest of salmon are also expected to have consumer surplus effects, but these effects could not be reliably quantified for this analysis.

4.3.2.3 Distributional Effects

Alternative 1—No Action

The analysis of regional economic effects focuses on the personal income contribution to the local economy generated by the ocean sport and commercial salmon fisheries. The local economy is defined as the county in which the port is located and, in some cases, counties adjacent to the port area. Total personal income consists of employee compensation and property income, which includes proprietary income (i.e., profits from self-employment) and other property income such as rental income, dividends, and corporate profits.

The personal income effects generated by ocean sport and commercial fishing for salmon under Alternative 1 are shown in Table 4.3-13 for Baseline 1. As shown, ocean sport and commercial fishing for salmon generates approximately $2.6 million in personal income in counties in the State of Washington, with the port of Grays Harbor accounting for the largest contribution to local personal income ($1.3 million). Ocean sport and commercial fishing for salmon in Oregon generates approximately $15.3 million in personal income, with the ports at Newport and Coos Bay accounting for more than 83 percent of the local income effects. Port activity at San Francisco and Monterey, California, account for 77 percent of the personal income generated statewide by ocean sport and commercial salmon fisheries and nearly 60 percent of local personal income generated by salmon fisheries regionwide.

For Baseline 2, local personal income generated by ocean sport and commercial salmon fishing is shown in Table 4.3-14. Compared to Baseline 1, regionwide local personal income is slightly lower ($77.1 million versus $80.3 million); however, local income generated by salmon fisheries is substantially lower in most Washington and Oregon counties and in California's KMZ counties, but generally higher in affected counties south of the KMZ.

Net income (profits) to businesses that are directly affected by ocean sport fishing for salmon is shown in Table 4.3-9 for Baseline 1 and Table 4.3-10 for Baseline 2. Under Alternative 1, these businesses would receive an estimated $2.0 million in profits annually. Angler spending on salmon fishing would generate approximately $328,000, $719,000, and $994,000 in net income for Washington, Oregon, and California businesses, respectively, for Baseline 1.

Alternative 2—Mark-Selective Fisheries, Option A

The distributional effects, as represented by personal income effects on the local economy, from ocean sport and commercial fishing for salmon under Alternative 2, Option A are shown in Table 4.3-13 for Baseline 1. Regionwide, ocean sport and commercial fishing for salmon under Alternative 2, Option A, would generate an additional $5.1 million in personal income at the local level, or 6 percent compared to Alternative 1. Under Alternative 2, Option A, an additional $7.0 million in personal income would be generated in Washington counties, representing an increase of more than 270 percent compared to Alternative 1. Personal income would increase by approximately $3.6 million in the Grays Harbor port area. In Oregon local personal income would increase by an estimated $10.0 million, with the Coos Bay port area accounting for an estimated $23.2 million and the Newport port area accounting for $3.0 million. In California local personal income generated by ocean sport and commercial salmon fishing would increase in the Crescent City port area (312 percent) and in the Eureka port area (35 percent) but would decrease by 20 to 25 percent in the other port area. Overall, local personal income generated by ocean sport and commercial salmon fisheries would decrease by approximately $12.0 million in California.

For Baseline 2, local personal income generated by ocean sport and commercial salmon fishing is shown in Table 4.3-14. Regionwide, ocean sport and commercial fishing for salmon under Alternative 2, Option A, would generate an additional $2.1 million (3 percent) in personal income in the local economy compared to Alternative 1. Alternative 2, Option A, would generate an additional $5.0 million (250 percent) in personal income in Washington counties compared to Alternative 1. Personal income generated by ocean sport and commercial salmon fisheries would increase by approximately $2.7 million in Grays Harbor and $1.4 million in the Columbia River-Washington port area. In Oregon local personal income would increase by $9.1 million, with Newport accounting for approximately $3.8 million and Coos Bay accounting for

Table 4.3-13. Personal income generated in the Council management area under Alternatives 1 and 2 for Baseline 1.

	Alternative 1			Alternative 2, Option A					Alternative 2, Option B				
						Total PI Generated in the Local Economy[1/]					Total PI Generated in the Local Economy[1/]		
Ports (County)	PI Generated by Sport Fishing	PI Generated by Commercial Fishing	Total PI Generated in the Local Economy	PI Generated by Sport Fishing	PI Generated by Commercial Fishing	Value	Change	% Change	PI Generated by Sport Fishing	PI Generated by Commercial Fishing	Value	Change	% Change
Washington Ports													
Neah Bay (Clallam, Jefferson)	$377,530	$93,696	$471,226	$1,187,858	$841,428	$2,029,286	$1,558,060	331	$377,530	$75,984	$453,514	($17,712)	(4)
La Push (Clallam, Jefferson)	$37,010	$28,383	$65,393	$116,484	$247,342	$363,826	$298,433	456	$37,010	$21,882	$58,892	($6,501)	(10)
Grays Harbor (Grays Harbor, Pacific)	$1,219,557	$126,352	$1,345,909	$3,837,132	$1,093,387	$4,930,519	$3,584,610	266	$1,219,557	$96,121	$1,315,678	($30,231)	(2)
Columbia River-Washington (Pacific, Wahkiakum)	$707,640	$4,968	$712,608	$2,226,309	$66,406	$2,292,715	$1,580,107	222	$707,640	$7,376	$715,016	$2,408	0
STATE TOTAL	**$2,341,737**	**$253,399**	**$2,595,136**	**$7,367,783**	**$2,248,563**	**$9,616,346**	**$7,021,210**	**271**	**$2,341,737**	**$201,363**	**$2,543,100**	**($52,036)**	**(2)**
Oregon Ports													
Columbia River(Oregon (Clatsop, Columbia)	$471,697	$3,312	$475,009	$1,484,265	$44,270	$1,528,535	$1,053,526	222	$471,697	$4,917	$476,614	$1,605	0
Tillamook (Tillamook)	$587,116	$892,282	$1,479,398	$1,193,785	$1,432,724	$2,626,509	$1,147,111	78	$592,154	$786,609	$1,378,763	($100,635)	(7)
Newport (Lincoln)	$1,746,916	$3,461,705	$5,208,621	$3,552,168	$4,664,130	$8,216,298	$3,007,677	58	$1,761,896	$3,124,325	$4,886,221	($322,400)	(6)
Coos Bay (Lane, Douglas, Coos, Curry)	$1,363,488	$6,120,288	$7,483,776	$2,772,507	$7,895,284	$10,667,791	$3,184,015	43	$1,375,192	$5,432,760	$6,807,952	($675,824)	(9)
Brookings (Lane, Douglas, Coos, Curry)	$293,478	$329,323	$622,801	$1,643,862	$590,824	$2,234,686	$1,611,885	259	$293,478	$238,427	$531,905	($90,896)	(15)
STATE TOTAL	**$4,462,695**	**$10,806,910**	**$15,269,605**	**$10,646,587**	**$14,627,232**	**$25,273,819**	**$10,004,214**	**66**	**$4,494,417**	**$9,587,038**	**$14,081,455**	**($1,188,150)**	**(8)**
California Ports													
Crescent City (Del Norte, Humboldt, Mendocino)	$238,773	$151,876	$390,649	$1,338,015	$272,462	$1,610,477	$1,219,828	312	$238,773	$109,900	$348,673	($41,976)	(11)
Eureka (Del Norte, Humboldt, Mendocino)	$256,810	$484,573	$741,383	$1,438,915	$868,917	$2,307,832	$256,811	35	$256,810	$350,805	$607,615	($133,768)	(18)
Fort Bragg (Mendocino)	$716,807	$11,718,105	$12,434,912	$716,807	$8,749,076	$9,465,883	($2,969,029)	(24)	$716,807	$8,749,076	$9,465,883	($2,969,029)	(24)
San Francisco (Sonoma, Marin, Alameda, San Francisco, San Mateo)	$4,620,082	$29,218,227	$33,838,309	$4,620,082	$21,815,393	$26,435,475	($7,402,834)	(22)	$4,620,082	$21,815,393	$26,435,475	($7,402,834)	(22)
Monterey (Santa Cruz, Monterey, San Luis Obispo)	$2,961,008	$11,513,290	$14,474,298	$2,961,008	$8,596,029	$11,557,037	($2,917,261)	(20)	$2,961,008	$8,596,029	$11,557,037	($2,917,261)	(20)
Santa Barbara (Santa Barbara, Ventura)	$0	$579,069	$579,069	$0	$432,675	$432,675	($146,394)	(25)	$0	$432,675	$432,675	($146,394)	(25)
STATE TOTAL	**$8,793,480**	**$53,665,140**	**$62,458,620**	**$11,074,827**	**$40,734,552**	**$51,809,379**	**($11,958,879)**	**(19)**	**$8,793,480**	**$40,053,878**	**$48,847,358**	**($13,611,262)**	**(22)**
REGION TOTAL	**$15,597,912**	**$64,725,449**	**$80,323,361**	**$29,089,197**	**$57,610,347**	**$86,699,544**	**$5,066,545**	**6**	**$15,629,634**	**$49,842,279**	**$65,471,913**	**($14,851,448)**	**(18)**

Notes:
1/ Change and % change for angler benefits and net income to businesses are in relation to Alternative 1—No Action.
PI = personal income
Personal income effects are for the county in which each port is located, which are shown in parentheses. Effects were estimated using personal income coefficients from IMPLAN, as derived from the Fishery Economic Assessment Model and used by the Council (Seger pers. comm.) Santa Barbara port area sport fishing effects are included in the Monterey port area effects.
All monetary values are in constant 1996 dollars.
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

Table 4.3-14. Personal income generated in the Council management area under Alternatives 1 and 2 for Baseline 2.

	Alternative 1			Alternative 2, Option A							Alternative 2, Option B		
						Total PI Generated in the Local Economy[1/]					Total PI Generated in the Local Economy[1/]		
Ports (County)	PI Generated by Sport Fishing	PI Generated by Commercial Fishing	Total PI Generated in the Local Economy	PI Generated by Sport Fishing	PI Generated by Commercial Fishing	Value	Change	% Change	PI Generated by Sport Fishing	PI Generated by Commercial Fishing	Value	Change	% Change
Washington Ports													
Neah Bay (Clallam, Jefferson)	$169,799	$351,895	$521,694	$964,044	$321,680	$1,285,724	$764,030	146	$214,057	$173,353	$387,410	($134,284)	(26)
La Push (Clallam, Jefferson)	$24,052	$18,617	$42,669	$107,751	$97,358	$205,109	$162,440	381	$23,953	$52,494	$76,447	$33,778	79
Grays Harbor (Grays Harbor, Pacific)	$563,621	$433,994	$997,615	$3,373,836	$277,426	$3,651,262	$2,653,647	266	$749,006	$234,088	$983,094	($14,521)	(1)
Columbia River-Washington (Pacific, Wahkiakum)	$433,332	$0	$433,332	$1,860,649	$17,043	$1,877,692	$1,444,360	333	$413,059	$9,177	$422,236	($11,096)	(3)
STATE TOTAL	**$1,190,804**	**$804,506**	**$1,995,310**	**$6,306,280**	**$713,507**	**$7,019,787**	**$5,024,477**	**252**	**$1,400,075**	**$469,112**	**$1,869,187**	**($126,123)**	**(6)**
Oregon Ports													
Columbia River-Oregon (Clatsop, Columbia)	$288,798	$0	$288,798	$1,240,464	$11,362	$1,251,826	$963,028	333	$275,409	$6,118	$281,527	($7,271)	(3)
Tillamook (Tillamook)	$313,163	$665,902	$979,065	$1,155,137	$748,088	$1,903,225	$924,160	94	$406,611	$741,974	$1,148,585	$169,520	17
Newport (Lincoln)	$1,340,631	$2,583,112	$3,923,743	$4,944,765	$2,822,200	$7,766,965	$3,843,222	98	$1,740,545	$2,813,284	$4,553,829	$630,086	16
Coos Bay (Lane, Douglas, Coos, Curry)	$626,005	$4,567,464	$5,193,469	$2,308,945	$4,964,040	$7,272,985	$2,079,516	40	$812,701	$4,948,680	$5,761,381	$567,912	11
Brookings (Lane, Douglas, Coos, Curry)	$176,344	$212,207	$388,551	$1,309,316	$375,470	$1,684,786	$1,296,235	334	$176,344	$153,824	$330,168	($58,383)	(15)
STATE TOTAL	**$2,744,941**	**$8,028,685**	**$10,773,626**	**$10,958,627**	**$8,921,160**	**$19,879,787**	**$9,106,161**	**85**	**$3,411,610**	**$8,663,880**	**$12,075,490**	**$1,301,864**	**12**
California Ports													
Crescent City (Del Norte, Humboldt, Mendocino)	$156,155	$9,807	$165,962	$1,159,424	$173,246	$1,332,670	$1,166,708	703	$156,155	$70,977	$227,132	$61,170	37
Eureka (Del Norte, Humboldt, Mendocino)	$154,102	$311,869	$465,971	$1,144,039	$552,421	$1,696,460	$1,230,489	264	$154,102	$226,288	$380,390	($85,581)	(18)
Fort Bragg (Mendocino)	$1,093,215	$11,000,360	$12,093,575	$1,093,215	$7,804,545	$8,897,760	($3,195,815)	(26)	$1,093,215	$8,215,441	$9,308,656	($2,784,919)	(23)
San Francisco (Sonoma, Marin, Alameda, San Francisco, San Mateo)	$8,249,702	$27,428,684	$35,678,386	$8,249,702	$19,460,451	$27,710,153	($7,968,233)	(22)	$8,249,702	$20,484,750	$28,734,452	($6,943,934)	(19)
Monterey (Santa Cruz, Monterey, San Luis Obispo)	$4,561,858	$10,807,859	$15,369,717	$4,561,858	$7,668,238	$12,230,096	($3,139,621)	(20)	$4,561,858	$8,071,918	$12,633,776	($2,735,941)	(18)
Santa Barbara (Santa Barbara, Ventura)	$0	$543,827	$543,827	$0	$386,046	$386,046	($157,781)	(29)	$0	$406,108	$406,108	($137,719)	(25)
STATE TOTAL	**$14,215,032**	**$50,102,406**	**$64,317,438**	**$16,208,238**	**$36,044,947**	**$52,253,185**	**($12,064,253)**	**(19)**	**$14,215,032**	**$37,475,482**	**$51,690,514**	**($12,626,924)**	**(20)**
REGION TOTAL	**$18,150,777**	**$58,935,597**	**$77,086,374**	**$33,473,145**	**$45,679,614**	**$79,152,759**	**$2,066,385**	**3**	**$19,026,717**	**$46,608,474**	**$65,635,191**	**($11,451,183)**	**(15)**

Notes:
1/ Change and % change for angler benefits and net income to businesses are in relation to Alternative 1—No Action.
PI = personal income
Personal income effects are for the county in which each port is located, which are shown in parentheses. Effects were estimated using personal income coefficients from IMPLAN, as derived from the Fishery Economic Assessment Model and used by the Council (Seger pers. comm.). Santa Barbara port area sport fishing effects are included in the Monterey port area effects.
All monetary values are in constant 1996 dollars.
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

$2.1 million. In California, local personal income generated by ocean sport and commercial salmon fishing would increase substantially in the Crescent City port area (703 percent) and in the Eureka port area (264 percent) but would be more than offset by decreases at ports south of the KMZ. Personal income generated by ocean sport and commercial salmon fisheries would decrease 20 to 29 percent in the Fort Bragg, San Francisco, Monterey, and Santa Barbara port areas. Overall, local personal income generated by ocean sport and commercial salmon fisheries would decrease by $12.1 million in California.

Net income (profits) to businesses that are directly affected by ocean sport fishing for salmon also is shown in Table 4.3-9 for Baseline 1 and Table 4.3-10 for Baseline 2. For Baseline 1, these businesses would receive an additional $2.1 million in profits, or more than 100 percent compared to Alternative 1. Angler spending on salmon fishing would generate an increase in net income of approximately $703,000, $1.0 million, and $394,000 for Washington, Oregon, and California businesses, respectively.

Alternative 2—Mark-Selective Fisheries, Option B

The distributional effects, as represented by personal income effects on the local economy, from ocean sport and commercial fishing for salmon under Alternative 2, Option B, are shown in Table 4.3-13 for Baseline 1. Regionwide, local personal income generated by ocean sport and commercial fishing for salmon under Alternative 2, Option B, would decrease by approximately $14.9 million, or 18 percent compared to Alternative 1. Alternative 2, Option B would result in decreases in personal income of approximately $52,000 in Washington counties, $1.2 million in Oregon counties, and $13.6 million in California counties. The largest reductions in personal income would be in the San Francisco port area ($7.4 million), the Fort Bragg port area ($3.0 million), and the Monterey port area ($2.9 million).

For Baseline 2, local personal income generated by ocean sport and commercial salmon fishing is shown in Table 4.3-14. Regionwide, local personal income generated by ocean sport and commercial fishing for salmon under Alternative 2, Option B, would decrease by approximately $11.5 million, or 15 percent compared to Alternative 1. Alternative 2, Option B would result in decreases in personal income of $126,000 in Washington counties and $12.6 million in California counties. Local personal income generated by ocean sport and commercial fishing for salmon would increase by approximately $1.3 million in Oregon counties. The largest reductions in personal income would be in the San Francisco port area ($6.9 million), the Fort Bragg port area ($2.8 million), and the Monterey port area ($2.7 million).

Under Alternative 2, Option B, net income (profits) to sport fishing-related businesses would be the same as under Alternative 1 (Baseline 1). Angler spending on salmon fishing would generate approximately $328,000 in net income for Washington businesses, $724,000 for Oregon businesses, and $994,000 for California businesses. For Baseline 2, potential reductions in net income to businesses that rely on spending by salmon anglers include approximately $171,000, $407,000, and $1.6 million to sport fishing-related businesses in Washington, Oregon, and California, respectively. The reduction in net income to sport fishing-related businesses would be less because some amount of substitution of local spending is likely.

The reduction in personal income would further contribute to a general decline, in the commercial salmon industry that has occurred over the past two decades. This further decline would adversely affect the marginal business climate that currently exists for salmon fishery-dependent businesses. This effect potentially would include further declines in the value of boats and equipment in some port areas used for commercial salmon fishing.

Alternative 3—No Incidental Take

Under Alternative 3, there would be no ocean sport or commercial troll fishing for salmon in coastal waters. The effect of this alternative would be to forego the personal income effects of these activities on the local economy that are generated under Alternative 1, which are shown in Table 4.3-13 for Baseline 1 and Table 4.3-14 for Baseline 2. Personal income generated by ocean sport and commercial salmon fishing in local economies throughout the region would be reduced by up to $80.3 million for Baseline 1. The actual amount that would be lost depends on the amount of fishing for other species that is substituted for salmon. In addition, angler spending in the local economy on substitute goods and services would reduce the negative effects on personal income. Assuming that no substitution of local spending occurs, local economies in Washington, Oregon, and California ports would lose approximately $2.6 million, $15.3 million, and $62.5 million in personal income, respectively. Personal income effects would be greatest in San Francisco ($33.8 million), Monterey ($14.5 million), and Fort Bragg ($12.4 million), California; and Coos Bay ($7.5 million) and Newport ($5.2 million), Oregon.

For Baseline 2, personal income generated by ocean sport and commercial salmon fishing in local economies throughout the region would be reduced by up to $77.1 million (Table 4.3-14). As indicated above, the actual amount that would be lost to local economies depends on the level of fishing for other species that would substitute for salmon. Assuming that no substitution of local spending occurs, local economies in Washington, Oregon, and California would lose approximately $2.0 million, $10.8 million, and $64.3 million in annual personal income, respectively. Personal income effects would be greatest in San Francisco ($35.7 million), Monterey ($15.4 million), and Fort Bragg ($12.1 million), California; and Coos Bay ($5.2 million), and Newport ($3.9 million), Oregon.

As indicated for Alternative 2, the reduction in personal income would further contribute to a general decline in the commercial salmon industry that have occurred over the past two decades. This further decline would adversely affect the marginal business climate that currently exists for salmon fishery-dependent businesses. This effect potentially would include further declines in the value of boats and equipment in some port areas used for commercial salmon fishing.

4.3.2.4 Social (Community) Effects

This section describes, primarily in qualitative terms, effects of the proposed alternatives on the commercial and recreational fishing communities, local (port) communities, Tribes, and counties.

Commercial Fishing Community

Alternative 1—No Action

Commercial fishing communities in the Council management area would receive an annual net income of approximately $7.0 million under Alternative 1 for Baseline 1 (Table 4.3-11). Net income levels would be highest for the San Francisco ($2.8 million), Monterey ($1.4 million), and Fort Bragg ($1.3 million) port communities in California. Net income levels from commercial salmon fishing would be lowest in the port communities of Columbia River-Oregon ($1,150), Oregon; Columbia River-Washington ($1,700), Washington; and Crescent City, California ($15,900).

For Baseline 2, annual net income from commercial salmon fishing is shown in Table 4.3-12. Compared to Baseline 1, annual net income from commercial salmon fishing would be lower ($6.4 million). Net income generated for commercial fishing communities would be highest in the San Francisco ($2.7 million), Monterey ($1.3 million), and Fort Bragg ($1.2 million) port areas in California. Communities in Columbia River-Washington and Columbia River-Oregon would receive no net income from commercial salmon fishing for Baseline 2.

Alternative 2—Mark-Selective Fisheries, Option A

Effects on the commercial fishing community under Alternative 2, Option A, vary by fishing area. For Baseline 1, Table 4.3-11 shows net income for commercial fishing under Alternative 2, Option A. For Baseline 1, commercial fishers operating from Washington and Oregon ports would experience increases in income because of increased fishing opportunity and harvest associated with mark-selective fisheries. Commercial fishers operating from Crescent City and Eureka would also experience increased harvests and income. Commercial fishers operating out of Fort Bragg, San Francisco, Monterey, and Santa Barbara would likely experience declines in income resulting from reduced harvests. The effects of Alternative 2, Option A differ between coastal regions and ports depending on their ability to take advantage of mark-selective fisheries. Generally in the north fishers get more fishing time and can increase their net catch. In the Fort Bragg area and other areas to the south, effort is largely unrestricted under Alternative 1. When mark-selective fisheries are implemented under Alternative 2, Option A there is a net loss in harvest because trollers must now release unmarked fish.

In relative terms, these income changes are large, ranging from decreases of 25 percent in the central-California ports to increases ranging from 37 to 1,174 percent in northern California, Oregon, and Washington ports. Areas experiencing the largest gains have had the most severe cutbacks in ocean salmon fishing seasons in recent years. In absolute terms the changes in net income are relatively small. The gain in net income for Washington port areas under Alternative 2, Option A for Baseline 1 would be approximately $287,000, or the equivalent of approximately $3,600 each for the 79 vessels landing each year in Washington. For Oregon ports the gain in net income of $676,000 equates to a change of approximately $1,300 annually per vessel. In California the decrease of $1.4 million in net income compared to Alternative 1 equates to a loss of approximately $1,400 per vessel.

Under Alternative 2, Option A (Baseline 2), per vessel increases in net income would be approximately $100 in Washington and $250 in Oregon (Table 4.3-12). In California net income would decrease by approximately $1,500 per vessel.

Alternative 2—Mark-Selective Fisheries, Option B

Under Alternative 2, Option B (Baseline 1), there would be a reduction in net income of $60 or less per vessel in Washington ports, $225 per vessel in Oregon, and $1,450 per vessel in California (Table 4.3-11).

For Baseline 2, both Washington and California would experience reductions in net income (Table 4.3-12). Per vessel income would decrease by approximately $530 in Washington and $1,350 in California. Oregon's per vessel net income would increase by approximately $180.

Alternative 3—No Incidental Take

As noted in Chapter 3, a recent survey estimated approximately 41 percent of Oregon salmon trollers were full-time fishers for whom salmon trolling was one of a mix of fisheries; for them, salmon trolling comprised approximately 12 percent of total income. Approximately 24 percent of the trollers were retirees and 35 percent had jobs in addition to fishing. For these groups salmon trolling provided less than 1 percent of total income. Assuming this is characteristic of the fleet coastwide, a closure of commercial salmon trolling would have only minimal financial effect on approximately 59 percent of the fleet but a substantial effect on the remaining 41 percent. The economic effect to the fleet could be offset by entry into other fisheries; however, salmon trollers who are full-time commercial fishers already participate in other fisheries. For those salmon fishermen who depend extensively on harvesting salmon for their income, the reduction in salmon harvest would likely increase social hardships, including the estrangement of families associated with the need to travel farther to fish or the need to move to find alternative employment.

The size of vessel used for salmon trolling dictates the use of longline, troll, or pot gear (as in crabbing) because the vessels are too small to be used for trawling, which requires larger boats with the horsepower sufficient to drag large nets through the water. Further expansion of crab fisheries is highly unlikely because more than enough gear exists coastwide to harvest available resources. All rockfish species, halibut, and blackcod are limited by quotas, and all stocks are currently used at maximum sustainable yield or are over-used. Further expansion into albacore fishing is possible under favorable market conditions; however, albacore are a far-ranging pelagic species that are most commonly harvested by Pacific trollers when favorable ocean conditions bring them to within 50 to 200 miles of the Pacific Coast. Targeting albacore more extensively than is already done by salmon trolling boats is problematic, given that most boats suitable for open-ocean fishing already participate to the maximum extent possible.

Recreational Fishing Community

Alternative 1—No Action

Angler trips by sport fishers provide an indication of the effects at the community level. As shown in Table 4.3-9, angler trips are predicted to total approximately 246,000 under the

Alternative 1 for Baseline 1. Approximately 49 percent of these trips would occur in recreational fishing communities in California, with the remainder in Oregon (35 percent) and Washington (16 percent). For Baseline 2, angler trips would total an estimated 260,000 trips (Table 4.3-10). For both Baselines 1 and 2, angler trips would be greatest in San Francisco and Monterey, California, and Newport, Oregon, and lowest in the Eureka and Crescent City, California, and Brookings, Oregon.

Alternative 2— Mark-Selective Fisheries, Option A

From 1988 to 1993 (Baseline 1), the observed number of angler trips coastwide averaged 518,000 annually with a mean variance of slightly more than 100,000 trips. From 1994 to 1997 (Baseline 2), there were approximately 319,000 observed angler trips per year with a mean variance slightly more than 70,000 trips. For Baseline 1, the fishery model predicts regionwide angler trips would be 503,000 under Alternative 2, Option A. For Baseline 2, the fishery model predicted there would be approximately 541,000 angler trips regionwide under Alternative 2, Option A, an increase of 281,000 trips compared to Alternative 1. In relation to historical fluctuations in effort, these changes are large; therefore, the regionwide effect on angler benefits and the angling community under Alternative 2, Option A is substantial for both Baselines 1 and 2. In percentage terms the greatest increase in benefits to the angling community occurs for anglers who fish in ports north of Fort Bragg, California (Tables 4.3-9 and 4.3-10). From Fort Bragg south, there is no change in angler effort predicted.

Alternative 2—Mark-Selective Fisheries, Option B

The fishery model predicts approximately 246,000 angler trips under Alternative 2, Option B for Baseline 1, a zero percent change compared to Alternative 1. For Baseline 2, approximately 274,500 angler trips would occur, a 6 percent increase compared to Alternative 1. Tables 4.3-9 and 4.3-10 show the number of angler trips in the Council management areas under Alternative 2 for Baselines 1 and 2, respectively.

Alternative 3—No Incidental Take

The effects on the recreational fishing community under Alternative 3 consist of a loss of recreational benefits for the consumer (anglers) and a loss of personal income for providers of goods and services for salmon anglers. As noted above, salmon angling is one of numerous recreational activities available to citizens within the region and anglers may respond to sport fishing closures by switching to another type of recreational fishery (e.g., halibut or rockfish) or freshwater fisheries. Based on license sales data, it would not appear that decreases in ocean fishing opportunity have been offset by increased freshwater fishing in Washington or Oregon during recent years. In the marine environment, particularly in the northern areas, options for other sport fisheries are increasingly limited because preferred rockfish species, lingcod, and halibut are currently being fully exploited or overexploited. Another option for anglers is to fish for salmon in other areas, such as British Columbia or Alaska. Increases in participation by Pacific Coast residents in British Columbia and Alaska salmon fisheries throughout the 1980s and 1990s have been well documented and, so long as fisheries remain open in Alaska and British Columbia, would be expected to increase further given closure of recreational salmon fisheries off the coasts of California, Washington, and Oregon.

Coastal Communities and Counties

Alternative 1—No Action

Regionwide personal income for coastal communities would total an estimated $80.3 million under Alternative 1 (Baseline 1) (Table 4.3-13). Personal income generated by commercial fishing activities would account for more than 80 percent of this total, with sport fishing accounting for 20 percent. Regionwide personal income levels would be highest in the San Francisco ($33.8 million), Monterey ($14.5 million), and Fort Bragg, California, ($12.4 million) port areas, and lowest in Crescent City, California ($391,000), Columbia River-Oregon, Oregon ($475,000), and Neah Bay, Washington ($536,600).

For Baseline 2, regionwide personal income generated by commercial and sport fishing would total approximately $77.1 million (Table 4.3-14), lower than Baseline 1 ($80.3 million). As with Baseline 1, personal income levels for Baseline 2 would be highest in the San Francisco, Monterey, and Fort Bragg port areas. Areas with relatively low levels of personal income would include Crescent City, California, and Columbia River-Oregon and Brookings, Oregon.

Alternative 2—Mark-Selective Fisheries, Option A

Under Alternative 2, Option A (Baseline 1), regionwide personal income for coastal communities would increase by an estimated $5.1 million (6 percent) (Table 4.3-13), which results from increased sport fishing activity. Port areas north of Fort Bragg, California, would experience gains ranging from 35 percent in the Eureka port area to 346 percent in the Neah Bay port area. Personal income would decrease for Fort Bragg and port communities south of Fort Bragg, with reductions ranging from 20 percent in Monterey to 25 percent in Santa Barbara, California.

Under Alternative 2, Option A (Baseline 2) regionwide personal income for coastal communities would increase by an estimated $2.1 million (3 percent) (Table 4.3-14). Personal income generated by sport fishing would offset losses from reduced commercial fishing. Port areas north of Fort Bragg, California, would experience gains ranging from 40 percent in the Coos Bay, Oregon, port area to more than 700 percent in the Crescent City, California, port area. Personal income would decrease for Fort Bragg and port communities south of Fort Bragg by 20 percent (Monterey) to 29 percent (Santa Barbara).

Although commercial salmon fisheries remain an important component of the multi-species fishing strategy for many commercial operators, and recreational fishing remains an important incentive for tourist visitations to coastal areas, personal income generated by commercial and recreational fishing is a relatively small component of local (county) economies within the Council management area and represents approximately 0.15 percent of the regionwide personal income of $33.8 billion. The only coastal county for which personal income derived from salmon sport or commercial fishing equaled or exceeded 1 percent of this total was Pacific County, Washington (1.2 percent), which is located at the mouth of the Columbia River. For the remaining Washington and Oregon counties salmon fishing provided between 0.1 to 0.5 percent of personal income effects, and in California the percentage ranged from 0.01 to 0.08 percent, except for Mendocino County (0.45 percent).

The change in personal income from one alternative to another does not have substantial short-term effects on county level economies within the Council management area;

however, commercial salmon fishing is an important increment of activity for the larger commercial fishing and processing industry and marginal decreases in income in one fishery, in combination with decreases in other fisheries, may produce broader effects on local economies and communities. Similarly, recreational fishing is one component of a mix of recreational opportunities that may attract visitors to a particular region. If it is an important enough component, visitors may choose another location with consequently broader effects on the tourist economy.

Alternative 2—Mark-Selective Fisheries, Option B

Under Alternative 2, Option B (Baseline 1), regionwide personal income would decrease by an estimated $14.9 million (18 percent), with reductions caused primarily by lessened commercial fishing activity and affecting virtually all coastal areas except for the Columbia River-Washington and Columbia River-Oregon port areas. Reductions would range from 2 percent (Grays Harbor, Washington) to 25 percent (Santa Barbara, California) (Table 4.3-13).

For Baseline 2 regionwide personal income would decrease by an estimated $11.5 million (15 percent) because of reduced commercial fishing activity. Most coastal areas would see reductions in personal income, ranging from 1 percent (Grays Harbor, Washington) to 18 percent (Neah Bay, Washington). Gains in personal income would be experienced by coastal communities in the Coos Bay (11 percent), Newport (16 percent), and Tillamook, Oregon (17 percent) port areas, and Crescent City, California (37 percent) port area (Table 4.3-14).

Alternative 3—No Incidental Take

As a result of the lost income noted above, fishing closures would likely result in additional closures of related businesses in Washington, Oregon, and California, including resort and charterboat businesses, marine supply and repair businesses, and possibly lodging and food service businesses. Over the past 10 or more years, businesses, especially resort and charter businesses and businesses in the northerly areas, have already ceased operating as a result of shortened and unpredictable seasons. The extent to which coastal communities replace salmon fishing-related tourism with other tourism depends on the community's location relative to major tourist routes, distance from major population centers, the diversity of recreational opportunity already available, and the diversity of service infrastructure. As shown in Table 4.3-15, the ability to replace salmon fishing-related tourism varies for each community and the severity of effects on individual communities can be expected to vary accordingly.

As noted previously, personal income derived from salmon fisheries accounts for approximately 0.15 percent of total personal income of counties within the region. Personal income from salmon fishing exceeds 1 percent of total county personal income in only one county; thus, even a total closure of salmon fishing would not be expected to substantially affect communities at a county or regional level.

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Table 4.3-15. Descriptions of community effects under Alternative 2 in the Council management area.

Port Area	Commercial Fishery Effects	Sport Fishery Effects	Social Importance
Washington			
Neah Bay	Baseline 1: Moderate ($135,600) increase in net income under IA 1. Very small ($1,800) decrease under IA 2. Baseline 2: Very small ($6,400) increase in net income under IA 1. Very small decrease ($19,000) under IA 2.	Baseline 1: Substantial increase in angler trips and benefits ($1,504,000) under IA 1. No change under IA 2. Baseline 2: Substantial increase in angler trips and benefits ($1,574,000) under IA 1. Small increase in trips and benefits ($79,500) under IA 2.	Fishing and fishing tourism are an important part of Neah Bay's economy, and Neah Bay is an important destination for anglers. However, owing to fishery closures, much of the fishing tourism infrastructure has disappeared. Salmon fishing is an important part of the tribal economy in La Push; however, most sport fishing infrastructure is gone from this port.
Grays Harbor	Baseline 1: Moderate ($130,700) increase in net income under IA 1. Very small ($3,400) decrease under IA 2. Baseline 2: Small ($20,500) decrease in net income under IA 1. Small decrease ($26,200) under IA 2.	Baseline 1: Substantial increase in angler trips and benefits ($2,649,000) under IA 1. No change under IA 2. Baseline 2: Substantial increase in angler trips and benefits ($2,817,000) under IA 1. Moderate increase in trips and benefits ($185,900) under IA 2.	Commercial salmon fishing is now a very minor part of the local economy. Angling tourism remains important.
Columbia River-Washington	Baseline 1: Small ($20,300) increase in net income under IA 1. Very small ($700) increase under IA 2. Baseline 2: Small ($5,900) increase in net income under IA 1. Small increase ($3,200) under IA 2.	Baseline 1: Substantial increase in angler trips and benefits ($1,800,000) under IA 1. No change under IA 2. Baseline 2: Substantial increase in angler trips and benefits ($1,743,000) under IA 1. Small decrease in trips and benefits ($24,600) under IA 2.	Commercial salmon fishing is now a very minor part of the local economy. Angling tourism remains important.
Oregon			
Columbia River-Oregon	Baseline 1: Small ($13,500) increase in net income under IA 1. Very small ($400) increase under IA 2. Baseline 2: Very small ($4,000) increase in net income under IA 1. Very small increase ($2,100) under IA 2.	Baseline 1: Substantial increase in angler trips and benefits ($1,739,000) under IA 1. No change under IA 2. Baseline 2: Substantial increase in angler trips and benefits ($1,162,000) under IA 1. Small decrease in trips and benefits ($16,500) under IA 2.	Commercial salmon fishing is now a very minor part of the local economy. Angling tourism remains important.
Tillamook	Baseline 1: Moderate ($122,900) increase in net income under IA 1. Small ($10,900) decrease under IA 2. Baseline 2: Small ($14,700) increase in net income under IA 1. Small increase ($13,500) under IA 2.	Baseline 1: Substantial increase in angler trips and benefits ($918,000) under IA 1. Very small increase in trips and benefits ($7,600) under IA 2. Baseline 2: Substantial increase in angler trips and benefits ($1,316,000) under IA 1. Moderate increase in trips and benefits ($146,000) under IA 2.	Commercial salmon fishing is now a very minor part of the local economy. Angling tourism remains important.

Table 4.3-15. Descriptions of community effects under Alternative 2 in the Council management area (continued).

Port Area	Commercial Fishery Effects	Sport Fishery Effects	Social Importance
Oregon (continued)			
Newport	Baseline 1: Moderate ($222,600) increase in net income under IA 1. Small ($26,100) decrease under IA 2. Baseline 2: Small ($36,500) increase in net income under IA 1. Small increase ($34,900) under IA 2.	Baseline 1: Substantial increase in angler trips and benefits ($2,234,000) under IA 1. Small increase in trips and benefits ($18,600) under IA 2. Baseline 2: Substantial increase in angler trips and benefits ($3,204,000) under IA 1. Moderate increase in trips and benefits ($355,500) under IA 2.	Commercial salmon fishing and angling tourism remain relatively important in this port area's economy. Newport is an important destination for Oregon anglers.
Coos Bay	Baseline 1: Moderate ($286,800) increase in net income under IA 1. Small ($70,900) decrease under IA 2. Baseline 2: Small ($55,400) increase in net income under IA 1. Small increase ($53,000) under IA 2.	Baseline 1: Substantial increase in angler trips and benefits ($2,003,000) under IA 1. Small increase in trips and benefits ($16,700) under IA 2. Baseline 2: Substantial increase in angler trips and benefits ($2,873,000) under IA 1. Moderate increase in trips and benefits ($318,700) under IA 2.	Commercial salmon fishing is a relatively minor part of the area economy. Coos Bay is an important destination for Oregon anglers, but the sport fishing infrastructure has declined markedly.
Brookings	Baseline 1: Small ($29,900) increase in net income under IA 1. Small ($10,400) decrease under IA 2. Baseline 2: Small ($18,700) increase in net income under IA 1. Very small decrease ($6,700) under IA 2.	Baseline 1: Substantial increase in angler trips and benefits ($2,429,000) under IA 1. No change under IA 2. Baseline 2: Substantial increase in angler trips and benefits ($2,121,000) under IA 1. No change under IA 2.	Commercial salmon is a relatively minor part of the area economy. Brookings is an important destination for Oregon and California anglers.
California			
Crescent City	Baseline 1: Small ($12,600) increase in net income under IA 1. Very small ($4,400) decrease under IA 2. Baseline 2: Very small ($7,900) increase in net income under IA 1. Very small decrease ($2,800) under IA 2.	Baseline 1: Substantial increase in angler trips and benefits ($1,666,000) under IA 1. No change under IA 2. Baseline 2: Substantial increase in angler trips and benefits ($1,455,000) under IA 1. No change under IA 2.	Commercial fishing is now a relatively minor part of the local economy owing to harvesting restrictions. The sport fishing infrastructure has declined markedly.
Eureka	Baseline 1: Small ($39,900) increase in net income under IA 1. Small ($13,900) decrease under IA 2. Baseline 2: Small ($25,000) increase in net income under IA 1. Very small decrease ($8,900) under IA 2.	Baseline 1: Substantial increase in angler trips and benefits ($1,660,000) under IA 1. No change under IA 2. Baseline 2: Substantial increase in angler trips and benefits ($1,449,000) under IA 1. No change under IA 2.	Commercial salmon fishing is an important part of the local economy; however, harvesting restrictions have decreased commercial salmon activity. Eureka is an important destination for anglers.

Table 4.3-15. Descriptions of community effects under Alternative 2 in the Council management area (continued).

Port Area	Commercial Fishery Effects	Sport Fishery Effects	Social Importance
California (continued)			
Fort Bragg	Baseline 1: Moderate ($336,700) decreases in net income under both IA 1 and IA 2. Baseline 2: Moderate ($362,400) decrease in net income under IA 1. Moderate decrease ($315,800) under IA 2.	No change in angler effort or benefits.	Commercial salmon fishing is now a very minor part of the local economy. Fort Bragg is an important destination for California anglers.
San Francisco	Baseline 1: Moderate ($720,100) decreases in net income under both IA 1 and IA 2. Baseline 2: Moderate ($775,100) decrease in net income under IA 1. Moderate decrease ($675,500) under IA 2.	No change in angler effort or benefits.	Commercial fishing is a very minor part of the local economy. Ports within the area are important destinations for California anglers.
Monterey	Baseline 1: Moderate ($346,900) decreases in net income under both IA 1 and IA 2. Baseline 2: Moderate ($373,300) decrease in net income under IA 1. Moderate decrease ($325,300) under IA 2.	No change in angler effort or benefits.	Commercial fishing is a very minor part of the local economy. Ports within the area are important destination for California anglers.
Santa Barbara	Baseline 1: Small ($10,800) decreases in net income under both IA 1 and IA 2. Baseline 2: Small ($11,600) decrease in net income under IA 1. Small decrease ($10,200) under IA 2.	No change in angler effort or benefits.	Commercial and sport fishing for salmon is a relatively minor part of the local economy.

Notes:
See Table 3.3-4 for the geographic description of port areas.
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

4.3.3 Comparison of Alternatives

4.3.3.1 Biological Environment

Under Alternative 2, the primary biological effect relative to Alternative 1would be a decrease in fishery-induced mortality of most stocks of wild chinook and coho salmon (Table 4.3-16). Options A and B provide a framework of a biologically liberal and a biologically conservative application of the mark-selective fishery approach, respectively.

Option A, as modeled, increases effects on the listed Lower Columbia River and Puget Sound chinook ESUs but reduces effects to other listed ESUs and substantially increases fishing opportunity in most areas. Option B decreases effects to all listed ESUs. In practice, it is possible to construct fishery management plans whose biological effects are intermediate between these two options.

Under Alternative 3, Pacific Coast fisheries would be closed. The biological effect on listed species, and other stocks in general, would depend on subsequent fisheries and additional sources of mortality, but would generally result in increased escapements. The expected effects for the listed ESUs and other stocks are discussed in more detail in Section 4.5, Cumulative Effects

Table 4.3-16. Mortality rates on listed chinook and coho ESUs under Alternatives 1 and 2 in the Council management area.

	Fishery Effect Rates (%)		
ESU	**Alternative 1**	**Alternative 2**	**Historical**
Chinook			
Sacramento River Winter	18	5	54
Sacramento River Fall	10	3 - 10	15 - 20
Snake River Spring/Summer	< 1	< 1	< 1
Puget Sound	3	1-5	2-4
Lower Columbia River	6	2-8	15
Willamette River Spring	≤ 1	< 1	< 1
Upper Columbia River Spring	≤ 1	≤ 5	≤ 1
Central Valley Spring	≤ 74	< 23 - 27	≤ 74
Southern Oregon/Northern California Coastal	Unknown	Unknown	Unknown
Coho			
Central California Coast	≤ 8 - ≤ 10	≤ 3 - ≤ 10	> 50
Southern Oregon/Northern California Coastal	≤ 8 - ≤ 10	≤ 3 - ≤ 10	> 50
Oregon Coast Natural	8-10	3-10	67

Notes: Mortality rates are approximate.
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. The catch would be zero.

4.3.3.2 Human Environment

Commercial Fishing Community

The overall effect under Alternative 2, Option A is to increase harvest opportunity in commercial and sport fisheries in the three northern management areas. Communities which have suffered proportionately greater effects from fishery closures in recent years (Neah Bay, La Push, Grays Harbor, Ilwaco, Astoria, Brookings, Crescent City, and Eureka) would see the greatest benefits. Within the commercial troll fleet it is common for some vessels to hold permits in more than one state and to range up and down the coast, depending on season openings and availability of fish. Other vessels, which probably comprise the majority of permits, fish close to their home port. Of these, vessels ported in the northerly areas would benefit somewhat more from increased fishing opportunities under Alternative 2. Conversely, the troll fishery off the central California coast, which has made the majority of landings over the past several years, would experience decreases in harvest and harvest efficiency under Alternative 2.

Sport Fishing Community

Under Alternative 2, substantially more economic benefit would be gained from recreational fisheries than commercial fisheries because in recreational fisheries benefits are more closely related to fishing opportunity rather than harvest. The extent to which catch-and-release regulations in mark-selective sport fisheries will change demand for recreational salmon fishing is unknown and it is possible that the lower harvest-per-unit-effort (as opposed to catch-per-unit-effort) may negatively affect demand.

Tribal Communities

Because commercial and ceremonial and subsistence troll fisheries are a large part of the economies of the Makah and Quileute Tribes, theses fisheries would be affected under both Alternatives 2 and 3. Other Tribes, who are not currently practicing commercial trolling but are allowed to by treaty agreements, could also be affected under Alternatives 2 and 3 if and when they wanted to troll commercially.

Klamath River Tribal fishermen are subject to regulations of the Klamath Fishery Management Plan, an agreement among the Hoopa, Round Valley, and Yurok Tribes; the State of California; and the federal government. Consequently, Klamath River Tribal fisheries are outside the scope of the action considered in this FPEIS and adoption of either alternative would not require the Klamath River Tribal fishers to change their management practices. Nevertheless, Klamath Tribal fishermen could be affected because, under certain abundance conditions, the total escapement of Klamath River chinook under Alternatives 2 and 3 would be different than under Alternative 1; however, these effects are projected to be relatively small. Under Alternative 1 (in the observed fisheries), ocean harvest opportunity is constrained in the northern California-southern Oregon area primarily by effects to Klamath River chinook and, consequently, has been extremely limited. Under Alternative 2, Option A, troll and sport fisheries would be less restrictive and would continue to maintain a harvest rate commensurate with goals of the KMP. For one baseline, modeled escapement of hatchery chinook to the Klamath River declined by approximately 1,000 fish; however, increased escapement of wild fish—if the Tribes chose to target these—could compensate for this decrease.

Effects under Alternative 3 on commercial and sport fishing communities would be substantial. There is little or no opportunity for commercial fishers to transfer to other fisheries and few opportunities exist to target other species in marine sport fisheries. Many sport fishing-related businesses in coastal communities have ceased operations over the past 10 to 15 years as a result of declining fishing opportunity. Although most of these businesses have income from other fisheries or tourist activities, Alternative 3 would likely result in further closures. As noted previously, personal income derived from salmon fisheries accounts for approximately 0.15 percent of total personal income of counties within the Council management area. Personal income from salmon fishing exceeds 1 percent of total county personal income in only one county; thus, even a total closure of salmon fishing would not be expected to cause large monetary effects on communities at a county or regional level.

4.3.3.3 Other Considerations

Any fishery management approach that relies on “targeting” a specific component of the aggregate stock of salmon is sensitive to errors in estimating the relative abundance of individual stocks within the aggregate for a given time and area. Although fishery managers have accumulated considerable data on stock distribution, uncertainty does exist regarding the accuracy of estimates for various stocks (Council 1999a).

When “targeted” or “directed” fisheries require the release of some part of the catch based on size, species, hatchery vs. wild, or other criteria, estimates of biological effects are also sensitive to the estimates of relative encounter rates (e.g., the proportion of encounters comprised by coho in a directed chinook fishery or the proportion of encounters comprised by hatchery coho in a mark-selective fishery) and the estimated mortality rate for those fish that are released. In mark-selective fisheries (Alternative 2) the number of fished released would increase in many cases compared to the status quo approach (Alternative 1); thus the importance of the two above estimates increases.

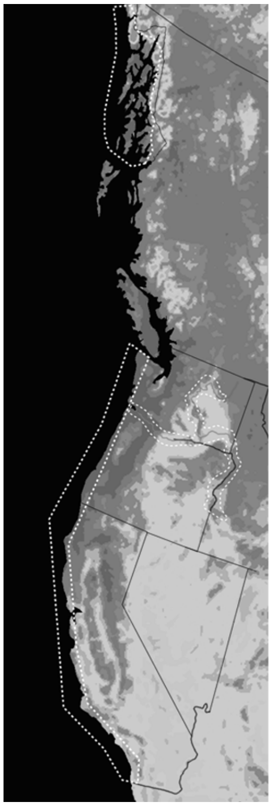
There is uncertainty about the proportion of naturally spawning (unmarked) fish in the Pacific Coast fisheries. Limited mark-selective fisheries in 1998 and 1999 have confirmed estimates of the proportions of marked and unmarked coho available to sport fisheries in northern Oregon; however, agencies have not systematically determined the ratio of natural to hatchery production for many chinook stocks. Estimates for Sacramento River fall chinook are of particular importance in the modeling of Council-managed fisheries because they vary widely (Myers et al. 1998).

In regard to uncertainties about the proportion of wild and hatchery fish encountered, it should be noted that marking hatchery fish can provide a means to accurately measure proportions of wild and hatchery runs both in marine and freshwater areas (see Section 4.5). Considerable uncertainty remains about mortality rates for catch-and-release hook-and-line fisheries. Short-term mortality has been studied in numerous coastal salmon fisheries and studies are largely in agreement that mortality varies according to gear, method, and species. Although the relationship between short-term and long-term mortality is not well established for marine salmon fisheries, numerous freshwater fisheries for trout, steelhead, and other species have been managed successfully as catch-and-release fisheries for several decades. The estimates of catch-and-release mortality for hook-and-line fisheries used in this FPEIS are those used by the ADF&G, Pacific Salmon Council, Council, and CDFG for their respective jurisdictions. Mortality rate estimates in all areas have been subject to fairly intensive review recently and those rates applied in Council-managed fisheries were modified prior to the 2000 fisheries to reflect the most recent research.

The various forms of uncertainty in the management process are understood by the managers and accounted for, to the degree possible, in different ways. In some cases, higher estimates of catch-and-release mortality, for example, may be used to account for uncertainty in the estimates. In other cases, quotas or target exploitation rates may be set lower to reduce the risk associated with uncertainty. Principles of weak stock management are also applied routinely across the fisheries considered in this FPEIS. Most fisheries are subject to multiple management constraints. For example, the Pacific coast fishery off the Oregon and California coasts must meet management objectives for Klamath Fall chinook, Sacramento winter run chinook, and Oregon coast natural coho among others. Once any of the conservation constraints is hit, fisheries are closed with the result that impacts to most of the affected stocks are below the conservation limits, thus providing a qualitative buffer for the uncertainty of impacts. Meanwhile, efforts to improve the models used to assess impacts and the parameters used in the models continue.

4.4 Columbia River Basin

4.4.1 Effects on the Biological Environment



This section presents an assessment of the biological effects for the proposed alternatives. Effects under Alternative 2—Live Capture, Selective, and Terminal Fisheries and Alternative 3—No Incidental Take are described in relation to Alternative 1—No Action. Two options under Alternative 2 are assessed. Option A represents a less restrictive approach that attempts to maximize socioeconomic benefits while meeting or exceeding present conservation objectives. Option B represents a biologically restrictive approach that attempts to maximize escapement of wild salmon stocks. Biological effects are described for listed and unlisted salmon and steelhead ESUs, mammals, birds, and lower trophic level species.

4.4.1.1 Analytic Approach and Assumptions

Analytic Steps

Alternative 1 for the Columbia River basin comprises the suite of management measures used during the baselines analyzed (1988 to 1993 and 1994 to 1997), including species-directed fisheries, time and area closures, gear regulations, and mark-selective sport fisheries for steelhead. Under Alternative 1 mortality on naturally spawning salmonids occurs from harvest. Alternative 2 proposes mass-marking of hatchery salmon and steelhead stocks and use of live capture gear in fisheries so that unmarked adult fish can be released with low incidental mortality. Under one option, selective fisheries are coupled with terminal area fisheries to more fully utilize harvestable surpluses. Management measures used under Alternative 1 are also incorporated under Alternative 2 as necessary. Under Alternative 2 mortality occurs as a result of catch-and-release. Under Option A, selective fisheries are implemented in mixed stock areas, which are coupled with terminal area fisheries that seek to utilize the available surpluses in areas where the impact to listed fish is exceptionally low. Encounter rates are assumed to be the same as under Alternative 1 with all unmarked fish released. Catches in mixed stock areas are, therefore, reduced with additional wild fish accruing to escapement. Fish in excess of escapement goals for hatchery and healthy wild populations are assumed to be caught in terminal fisheries. Although Tribal participation in selective fisheries is discretionary, the analysis assumes that the Tribes will also implement selective fishing methods. Option B is more restrictive and considers only the use of selective fisheries in mixed stock areas.

Under Alternative 3, no incidental take of listed fish would be authorized. As a result, all fisheries that may affect listed fish would be closed. Although the no take requirement may still allow for some limited harvest opportunity in some terminal areas, for purposes of this analysis, NMFS assumed that all fisheries in the Columbia River Basin would be closed.

The analysis of short-term effects on salmon and steelhead was conducted as follows:

1. A retrospective analysis incorporating run sizes from two baselines—1988 to 1993 (Baseline 1) and 1994 to 1997 (Baseline 2)—was used.
2. The proportion of hatchery and naturally produced fish for the major salmon and steelhead runs was estimated and all hatchery fish were assumed to be marked.[8,9] Values used to estimate runs and harvests of hatchery and natural salmon and steelhead are shown in Table 4.4-1.
3. It was assumed that the total encounter of fish by "selective" gear would be the same as traditional (status quo) gear, even though the effort (fishing days) required to encounter the same number of fish might be different when selective fishing gears are employed.
4. Selective gears were not specified but were assumed to be restricted to those having an incidental mortality rate of 10 percent or less for salmon and steelhead.
5. Because retention of hatchery fish and release of naturally produced fish in Zones 1 through 5 (lower river) would cause the proportion of wild fish (compared to hatchery fish) entering Zone 6 (upper river) to increase, adjustments in the composition of stocks entering Zone 6 were made accordingly. For example, selective fishing for upriver bright fall hatchery chinook in Zones 1 through 5 during 1988 to 1993 would have led to a 3 percent decrease in the percentage of hatchery fish entering Zone 6. Incidental mortality of naturally produced upriver fall chinook from fishing in Zones 1 through 5 were included in this adjustment.
6. An additional terminal harvest opportunity was considered under Alternative 2, Option A, for several stocks, including Upriver Fall chinook, Lower Columbia River coho, Upriver Summer steelhead, and Upper Columbia River sockeye. The average expected escapements were calculated for each baseline after accounting for impacts associated with selective fisheries. NMFS assumed that all fish in excess of the escapement goal would be harvested in terminal fisheries. This approach, therefore, provides an upper estimate of the potential harvest benefits. There are likely to be terminal area harvest opportunities for other stocks in some years, but, generally speaking, wild stock escapement goals for other stock groups were not met during the baselines considered. Additional terminal harvest opportunities were, therefore, not generally apparent.
7. To estimate changes in spawning escapement, effects on key natural stocks from fishing were adjusted, where possible, to account for subsequent mortality associated with migration of the surviving fish past dams upstream of the fisheries. For Snake River dams, reported mortality was used (ODFW and WDFW 1998). A mortality rate of 3 percent per dam was assumed for fish returning to other areas (NMFS 1999b).

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[8] Stock composition was based on reported estimates, estimates generated through discussions with harvest managers (C. LeFleur, G. Norman, D. Rawding, WDFW, personal communication), or on the number of fish returning to hatcheries compared to the spawning grounds. In the latter case, numbers of hatchery fish in the run included those hatchery fish returning to hatcheries plus those hatchery fish estimated or assumed to have strayed to the spawning grounds. Hatchery fish straying to the spawning grounds were subtracted from the natural spawners estimate.

[9] This analysis assumes that all hatchery fish are visually marked. Some hatcheries release salmon and steelhead that are important to the recovery of listed species, and it is likely that these fish would not be marked (or would be marked differently) so that fishermen would not retain these selected hatchery stocks. This analysis did not attempt to incorporate these unmarked hatchery fish into the analysis, but they would have little effect on total harvests if they were removed.

Table 4.4-1. Percentages of salmon and steelhead runs in the Columbia River basin assumed to originate from hatcheries.

Stock	Percentage of Natural Spawners Originating from Hatcheries[1/]	(%) Run Originating from Hatcheries
Upriver Fall Chinook		
Upriver Bright	5	
Bonneville Pool Hatchery (natural run)	50	
Mid-Columbia River Brights (natural component)	Linear decrease from 80 percent in 1988 to 25 percent in 1997	
Lower Columbia River Fall Chinook		
Natural	5	
Hatchery (natural component)	70	
Upriver Spring Chinook		65 percent in mainstem, 95 percent in terminal areas where harvest is currently allowed
Lower River Spring Chinook		90
Rogue River Bright (SAFE)		100
Upriver Summer Chinook		40
Coho		90
Sockeye		<5
Lower River Winter Steelhead		80
Lower River Summer Steelhead		95
Upriver Summer Steelhead		77/82[2]

Notes:
When an estimate of hatchery fish in a run was not available, numbers of natural and hatchery escapements were used to estimate the ratio in the mixed stock harvests; however, some hatchery fish stray to the spawning grounds, therefore the natural spawner estimates were adjusted with estimates of hatchery strays. For example, it was assumed that 5 percent of the Lower River Wild chinook run returning to the spawning grounds had originated from hatchery strays. Note that some natural runs were started by hatchery strays and continue to be supplemented with hatchery strays (e.g., Bonneville Hatchery and Lower River Hatchery). Reported annual values were used for upriver summer steelhead (A&B runs, ODFW and WDFW 1998).
1/ Values used to adjust natural run size
2/ Values are for Baselines 1 and 2, respectively.
SAFE = selective
Sources: C. LeFleur, G. Norman, and D. Rawding, WDFW, personal communication.

Management Objectives

Biological management objectives used to constrain harvests or incidental take in the model included CRFMP escapement or harvest rate goals for Upriver Spring, Lower River Fall, Willamette spring, Upriver Summer, and Upriver Fall chinook stock groups; Summer and Winter steelhead; sockeye, coho; and chum. Those objectives and their relationship to listed ESUs are shown in Table 3.5-2.

Specification of Management Measures

Fisheries were modeled using the management measures (season, gear type, etc.) specified in Tables 2.2-3 and 2.2-4.

4.4.1.2 Fisheries and Harvests

Alternative 1—No Action

A total of 798,000 salmon and steelhead per year were harvested by all Columbia River basin fisheries for Baseline 1 (Table 4.4-2) and 259,000 were harvested for Baseline 2 (Table 4.4-3). For Baseline 1, coho comprised 41 percent of total harvest (weighted mean), followed by chinook salmon (32 percent) and steelhead (26 percent) (Table 4.4-2). For Baseline, 2 steelhead comprised 45 percent of the harvest, followed by chinook (36 percent) and coho (18 percent) (Table 4.4-2). For Baseline 1, non-Tribal commercial fisheries below Bonneville Dam took 40 percent of the total harvest, followed by recreational fisheries (44 percent), Tribal commercial fisheries (13 percent), and Tribal ceremonial and subsistence fisheries (3 percent). For Baseline 2, lower river commercial fisheries declined to 16 percent of previous levels because of smaller returns of coho and chinook and more restrictive regulations. Anglers took 59 percent of the harvest, Tribal commercial fishermen took 18 percent, and ceremonial and subsistence fishermen took 6 percent.

Chinook harvests were dominated by lower river fall chinook and upper river fall chinook for both Baselines 1 and 2. Few summer chinook, chum, sockeye, and upriver spring chinook were harvested because they were not targeted or they were targeted by small ceremonial and subsistence fisheries. Average annual harvests by commercial, recreational, Tribal commercial, and Tribal ceremonial and subsistence fisheries for Baselines 1 and 2 are summarized in Figure 4.4-1 and detailed in Tables 4.4-2 and 4.4-3.

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option A

Alternative 2, Option A, considers the environmental consequences of implementing selective fisheries in mixed stock areas and terminal fisheries in areas where surplus fish remain available. The analysis assumed that the number of fish encountered in the mixed stock fisheries would be the same as that during Alternative 1. In most cases under Alternative 2, fishers would use different gear types that allowed for live release on non-targeted fish. If the new gears were less efficient than the gears used in Alternative 1, more effort would be required to encounter the same number of fish.

Opportunities exist to harvest additional hatchery coho salmon in lower river sport and commercial fisheries by allowing increased fishing effort. Fish from naturally produced upriver bright fall chinook released in Zones 1 through 6 could be harvested in the Hanford Reach, which is upstream of the Snake River confluence, the system of origin for the listed Snake River fall chinook runs. Although upriver bright chinook do not physically deteriorate as quickly as tule chinook, the quality and value of chinook harvested in terminal areas would be diminished compared to those harvested in Zones 1 through 6. A relatively large number of hatchery-produced upriver summer steelhead would escape fisheries under the effort levels assumed in Alternative 2, Option A. Increasing the season length, fishing effort, or harvest efficiency would result in the harvest of many of these hatchery steelhead. Substantial increases in efficiency for sport fisheries are unlikely, but some commercial and ceremonial and subsistence gear types used with mark-selective fisheries may be more efficient than the traditional gillnets.

Table 4.4-2. Summary of Columbia River fishery harvests under Alternatives 1 and 2 for Baseline 1.

ESU or Run	Zones 1-5 Commercial	Zones 1-6 and Tributary Sport	Zone 6 and Tributary Tribal Commercial	Zone 6 and Tributary Ceremonial and Subsistence	Tribal Ceremonial and Subsistence	Total
Alternative 1						
Lower River Fall Chinook	61.60	18.10	0.50	0.00		80.20
Upper River Fall Chinook	23.80	8.10	55.60	0.00		87.50
Summer Chinook	0.00	< 0.10	0.00	0.13	0.00	0.13
Lower River Spring Chinook	10.10	54.80	0.00		0.00	65.00
Upper River Spring Chinook	1.70	12.70	< 0.10	6.20	5.00	25.60
Coho	221.80	101.40	2.90	00		326.00
Upriver Summer Steelhead	0.00	92.60	43.30	5.80	4.70	146.40
Lower River Steelhead	0.00	57.70	0.180	0.00	0.00	57.90
Sockeye	0.20	3.80	1.50	3.00		8.50
Chum	1.00	0.00	0.00	0.00	0.00	1.00
Total	**320.10**	**349.30**	**104.00**	**15.10**	**9.80**	**798.20**
Alternative 2, Option A						
Lower River Fall Chinook	44.80	12.80	0.40	0.00	0.00	57.90
Upper River Fall Chinook	11.00	15.10	100.00	0.00		126.10
Summer Chinook	0.00	0.00	0.00	0.05	0.00	0.05
Lower River Spring Chinook	9.10	49.30	0.00	0.00	0.00	58.50
Upper River Spring Chinook	1.10	12.10	0.00	4.00	4.80	22.00
Coho	273.30	124.90	3.50	0.00	0.00	401.80
Upriver Summer Steelhead	0.00	103.40	38.60	5.20	4.10	151.30
Lower River Steelhead	0.00	57.70	0.10	0.00	0.00	57.80
Sockeye	0.00	8.70	3.40	6.80	0.00	19.00
Chum	0.00	0.00	0.00	0.00	0.00	0.00
Total	**339.30**	**384.10**	**146.00**	**16.10**	**8.90**	**894.50**
Alternative 2, Option B						
Lower River Fall Chinook	44.80	12.80	0.40	0.00	0.00	57.90
Upper River Fall Chinook	8.60	3.60	21.10	0.00		33.30
Summer Chinook	0.00	0.00	0.00	0.05	0.00	0.05
Lower River Spring Chinook	9.10	49.30	0.00	0.00	0.00	58.50
Upper River Spring Chinook	1.10	12.10	0.00	4.00	4.80	22.00
Coho	199.60	91.20	2.60	0.00		293.40
Upriver Summer Steelhead	0.00	92.60	33.50	4.50	3.60	134.20
Lower River Steelhead	0.00	57.70	0.10	0.00	0.00	57.80
Sockeye	0.00	3.80	0.00	0.00	0.00	3.80
Chum	0.00	0.00	0.00	0.00	0.00	0.00
Total	**263.20**	**323.20**	**57.70**	**8.60**	**8.40**	**661.10**

Notes:
Values are 1,000s of fish.
Some of the stock groups shown represent multiple ESUs or multiple sub-components of the total run, and these sub-components may have different harvest rates than that expressed for the entire stock group. For example, A-Run steelhead have a lower harvest rate than B-Run steelhead and natural Willamette spring chinook have a much lower harvest rate than that shown for the lower river spring chinook stock group. Combining sub-components of larger stock groups was necessitated by the need to provide a tractable analysis of potential costs and benefits for the fishery alternatives considered in this FPEIS and because harvest data for many sub-components are not known, e.g., steelhead ESUs.
Sources: ODFW/WDFW 1998; Council 1999b; CRITFC 1999; Bosch 1998; TAC 1999 a, b; and J. Mauney, Nez Perce Tribe, personal communication.

Table 4.4-3. Summary of Columbia River fishery harvests under Alternatives 1 and 2 for Baseline 2.

ESU or Run	Zones 1-5 Commercial	Zones 1-6 and Tributary Sport	Zone 6 and Tributary Tribal Commercial	Zone 6 and Tributary Ceremonial and Subsistence	Tribal Ceremonial and Subsistence	Total
Alternative 1						
Lower River Fall Chinook	5.60	7.60	0.20	0.00	0.00	13.30
Upper River Fall Chinook	2.20	10.20	35.80	0.00		48.10
Summer Chinook	0.00	< 0.10	0.00	0.35	0.00	0.35
Lower River Spring Chinook	1.20	19.90	0.00		0.24	21.20
Upper River Spring Chinook	0.125	4.40	< 0.10	3.20	2.50	10.20
Coho	33.50	13.30	0.40	0.00		47.20
Upriver Summer Steelhead	0.00	60.00	10.00	6.80	1.80	78.70
Lower River Steelhead	0.00	38.40	0.06	0.00	0.00	38.50
Sockeye	0.00	0.00	0.00	1.10		1.10
Chum	< 0.10	0.00	0.00	0.00	0.00	0.00
Total	**42.60**	**153.80**	**46.50**	**11.50**	**4.50**	**258.80**
Alternative 2, Option A						
Lower River Fall Chinook	4.20	5.50	0.10	0.00	0.00	9.90
Upper River Fall Chinook	1.20	23.30	60.50	0.00		85.00
Summer Chinook	0.00	0.00	0.00	0.14	0.00	0.14
Lower River Spring Chinook	1.00	17.90	0.00	0.00	0.21	19.10
Upper River Spring Chinook	0.10	4.20	0.00	2.10	2.40	8.80
Coho	52.30	20.80	0.60	0.00		73.70
Upriver Summer Steelhead	0.00	96.60	14.30	9.80	2.60	123.40
Lower River Steelhead	0.00	38.40	0.10	0.00	0.00	38.50
Sockeye	0.00	0.00	0.00	0.00	0.00	0.00
Chum	0.00	0.00	0.00	0.00	0.00	0.00
Total	**58.80**	**206.80**	**75.60**	**12.00**	**5.20**	**358.40**
Alternative 2, Option B						
Lower River Fall Chinook	4.20	5.50	0.10	0.00	0.00	9.90
Upper River Fall Chinook	0.90	10.10	13.90	0.00	0.00	24.90
Summer Chinook	0.00	0.00	0.00	0.14	0.00	0.14
Lower River Spring Chinook	1.00	17.90	0.00	0.00	0.21	19.10
Upper River Spring Chinook	0.10	4.20	0.00	2.10	2.40	8.80
Coho	30.20	12.00	0.40	0.00	0.00	42.50
Upriver Summer Steelhead	0.00	60.00	8.20	5.60	1.50	75.30
Lower River Steelhead	0.00	38.40	0.10	0.00	0.00	38.50
Sockeye	0.00	0.00	0.00	0.00	0.00	0.00
Chum	0.00	0.00	0.00	0.00	0.00	0.00
Total	**36.40**	**148.10**	**22.70**	**7.90**	**4.10**	**219.10**

Notes:

Values are 1,000s of fish.

Some of the stock groups shown represent multiple ESUs or multiple sub-components of the total run, and these sub-components may have different harvest rates than that expressed for the entire stock group. For example, A-Run steelhead have a lower harvest rate than B-Run steelhead and natural Willamette spring chinook have a much lower harvest rate than that shown for the lower river spring chinook stock group. Combining sub-components of larger stock groups was necessitated by the need to provide a tractable analysis of potential costs and benefits for the fishery alternatives considered in this FPEIS and because harvest data for many sub-components are not known, e.g., steelhead ESUs.

Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. The catch would be zero.

Sources: ODFW and WDFW 1998; Council 1999b; CRITFC 1999; Bosch 1998; TAC 1999 a, b; and J. Mauney, Nez Perce Tribe, personal communication.

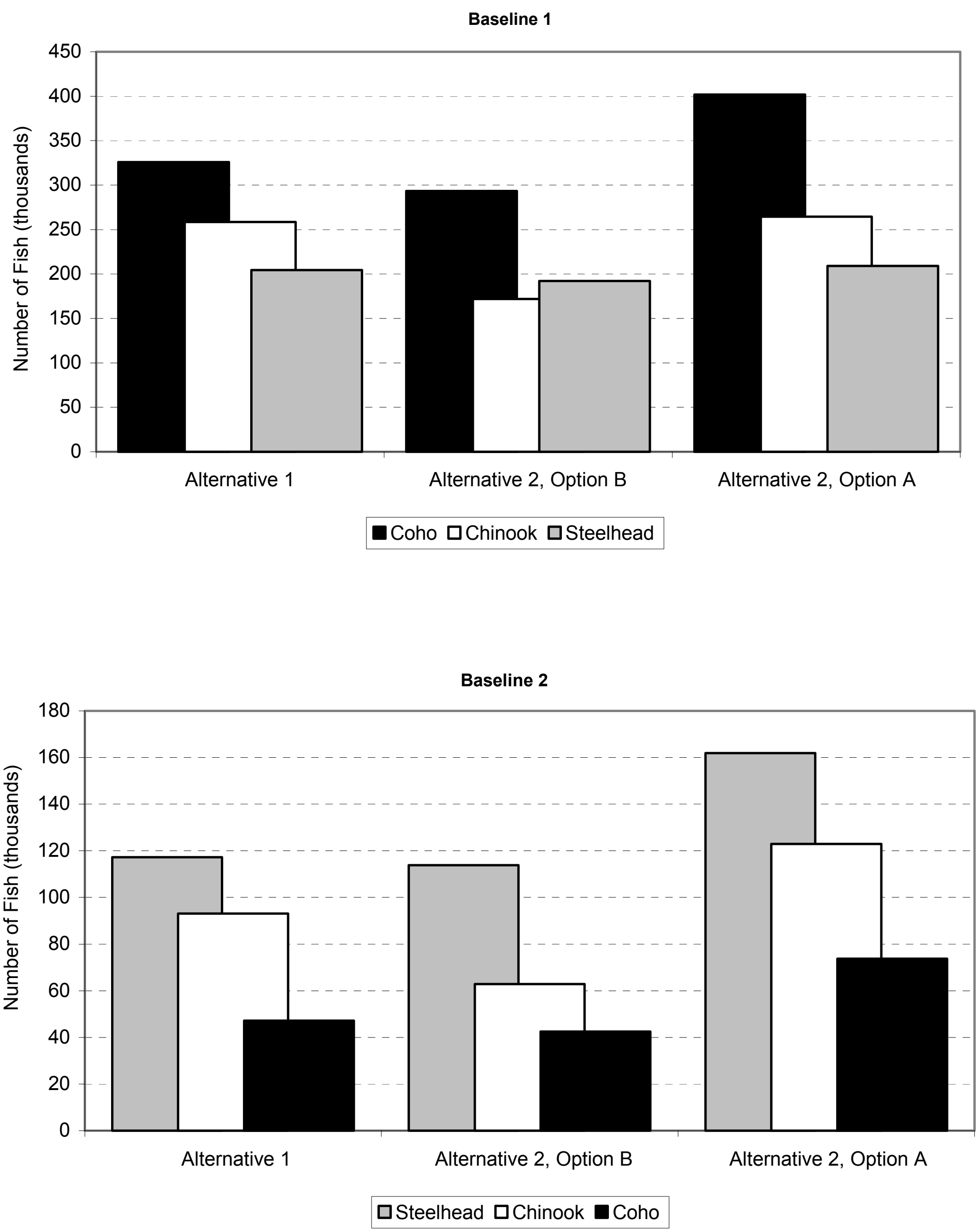

Figure 4.4-1. Harvests of chinook, coho, and steelhead in Columbia River basin fisheries under Alternative 1 (observed) and Alternative 2.

Generally, the total catch of salmon and steelhead would be higher under Alternative 2, Option A. The total expected catch under Baselines 1 and 2 would be 895,000 and 358,000, respectively, compared to 798,000 and 259,000 under Alternative 1 (Tables 4.4.2 and 4.4.3). The distribution of catch among species would not change substantially compared to Alternative 1. Under Baseline 1, coho would comprise 45 percent of the catch followed by chinook (30 percent) and steelhead (26 percent). Under Baseline 2, steelhead would comprise 45 percent of the harvest, followed by chinook (34 percent) and coho (21 percent). However, the distribution of catch between stocks would change depending on whether there was terminal harvest opportunity to make up for the harvest reductions that would occur in the selective, mixed stock fisheries.

The analysis assumes that the encounter rate of fish in the mixed stock fisheries under Alternative 2 would be the same as that under Alternative 1. However, since unmarked fish would be released, catch would be reduced in proportion to the relative abundance of hatchery and wild fish. For example, 90 percent of lower river spring chinook is assumed to be hatchery fish (Table 4.4.1). Under Alternative 1, Baseline 1, the catch of lower river spring chinook is 65,000. Under Alternative 2, Baseline 1, the catch is reduced by 10 percent to 58,500 (Table 4.4.2) because unmarked fish are now being released in the selective fisheries and because there was presumably no additional opportunity for terminal area fisheries for these stocks given the baseline conditions considered.

For some stocks, catch would increase under Alternative 2 because of the additional terminal fishing opportunity. Given the assumed management objectives and baselines considered, terminal harvest opportunities were apparent for upriver fall chinook, Lower Columbia River coho, upriver summer steelhead, and at least in Baseline 1, upper Columbia River sockeye. As an example, the harvest of coho would increase from 326,000 under Alternative 1, Baseline 1, to 402,000 under Alternative 2, and from 47,000 under Alternative 1, Baseline 2, to 74,000 under Alternative 2 (Tables 4.4.2 and 4.4.3). For upriver fall chinook, the harvest would increase from 87,500 under Alternative 1, Baseline 1, to 126,000 under Baseline 2, and from 48,000 under Alternative 1, Baseline 2, to 85,000 under Alternative 2 (Tables 4.4.2 and 4.4.3). Table 4.4.4 summarizes the maximum additional harvest gain that could be realized for stocks that are accessed through additional terminal fisheries. For example, under Alternative 2, Baseline 1, Option A would provide a net gain in harvest of up to 76,000 coho compared to Alternative 1. This analysis assumes that all fish that exceed the escapement goal can be harvested in terminal fisheries. Although terminal fisheries are conceptually appealing, there are likely to be practical considerations that limit the ability to access all of the available surplus that will be specific to each fishery. If surplus fish cannot be fully accessed in the terminal fisheries, the gains in harvest will be lower than those shown in Table 4.4.4.

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option B

Under Alternative 2, Option B, which assumes total harvest would remain the same as Under Alternative 1, harvests of all stocks would decrease in approximate proportion to the percentage of unmarked fish released. The harvest of coho would have the smallest proportionate decrease (10 percent) because of their predominately hatchery origin.

Table 4.4-4. Estimated maximum additional harvests of hatchery salmon and "healthy" wild fall chinook and sockeye under Alternative 2, Option A.

Baseline	Selective Fishery Escapement	Assumed Escapement Goal	Surplus for Harvest	Net Harvest Gain/Loss	Natural Releases	Incidental Mortalities	Total Incidental Mortality	Escapement Increase	Bycatch Species
Target: Upriver Hatchery Fall Chinook									
Baseline 1	38.7	30.0	8.7	8.7	12.2	1.2	6.6	0	steelhead
Baseline 2	36.6	30.0	6.6	6.6	9.2	0.9	3.2	0	steelhead
					(releases may be lower if move to terminal areas)				
Target: Upriver Natural Bright Fall Chinook above Snake River Confluence									
Baseline 1	127.5	43.5	84.0	29.8	0		included above	0	steelhead
Baseline 2	97.0	43.5	53.5	30.3	0		included above	0	steelhead
Target: Hatchery Coho Salmon (all fisheries)									
Baseline 1	146.4	38	108.4	75.8	12.0	1.2	4.5	28.1	chum, steelhead
Baseline 2	69.2	38	31.2	26.5	3.5	0.3	0.8	3.9	chum, steelhead
Target: Hatchery Upriver Summer Steelhead (A&B Runs)									
Baseline 1	67.1	50	17.1	4.9	3.8	0.4	1.5	9.8	chinook
Baseline 2	98.0	50	48.0	44.7	8.7	0.9	1.2	2.0	chinook
Target: Upper Columbia River Wild Sockeye above Snake River Confluence									
Baseline 1	80.1	65	15.1	10.5	0.0			(10.5)	steelhead
Baseline 2	23.8	65	0.0	(1.1)	0.0			1.1	steelhead
Totals									
Baseline 1			**233.4**	**129.8**					
Baseline 2			**139.3**	**107.0**					

Notes:

These values are approximations and they represent maximum potential harvests. Actual harvests would depend on availability of fish to fishermen in specific locations and the ability of fishermen to harvest the surplus fish. Net harvest gain/loss is the difference between total potential harvests under Alternative 2 and Alternative 1. Escapement increase beyond the observed escapement is shown after subtracting cumulative estimated incidental fishing mortalities. Additional harvests could lead to additional incidental mortalities of non-target species, which are not shown here. These estimates of harvest are based on the calculated number of fish escaping beyond Zones 1 through 6 (after subtracting incidental mortality) minus the escapement goal.

The maximum potential harvests of hatchery fish were based on the difference between run sizes and hatchery escapement goals.

Values are 1,000s of fish.

Data sources: ODFW and WDFW 1998; Council 1999b; CRITFC 1999; Bosch 1998; TAC 1999 a, b; J. Mauney, Nez Perce Tribe, personal communication.

Harvest of upriver fall chinook and lower river chinook would decrease 62 percent and 28 percent, respectively. Upriver steelhead harvest would decrease approximately 8 percent, and lower river steelhead harvest would remain the same.

Because different fishery groups depend on different stocks to varying degrees, commercial, sport, and Tribal fishers would be affected differently under Alternative 2, Option B. Tribal fishers who depend on upriver fall chinook and steelhead runs would experience more than a 40 percent harvest decline under this alternative for Baselines 1 and 2. Anglers and non-Tribal commercial fishers would experience a 4 to 10 percent and a 15 to 22 percent decline in harvest, respectively, depending on the baseline.

Sockeye salmon have not been targeted by commercial fisheries since 1988 but limited harvests (less than 5 percent for runs less than 50,000 fish) have been allowed each year in ceremonial and subsistence fisheries in Zone 6. Implementation of Alternative 2, Option B for Baseline 1 would lead to harvest losses in non-Tribal and Tribal commercial fisheries

(Zones 1 through 6) of approximately 200 and 1,500 sockeye per year, respectively, compared to Alternative 1 (Tables 4.4-2 and 4.4-3). Annual harvest losses in the Zone 6 ceremonial and subsistence fishery would be 3,000 and 1,100 fish for Baselines 1 and 2, respectively.

Chum salmon are presently captured as bycatch in lower river commercial fisheries. Releasing chum salmon taken with live capture gear would result in average annual mortality of less than 100 chum for Baseline 1 and fewer than 10 fish per year for Baseline 2.

Alternative 3—Incidental Take

Under Alternative 3, reductions in harvest would be equivalent to catches observed in Baselines 1 and 2 in the alternatives. Escapements to hatcheries and natural production areas would increase. The response of natural populations would depend on their current status and trends relative to harvest impact levels. Absent harvest, the need for survival improvements in other life stages would diminish, but whether elimination of harvest would be sufficient to provide for recovery depends on the magnitude of impacts in other sectors. For species already subject to low harvest rates, elimination of harvest would provide relatively little survival improvement. There would be some additional harvest opportunity in terminal areas where listed fish are not present. Production hatcheries would likely be closed since the fish are being produced primarily to provide fishing opportunities. Hatcheries used for supplementing natural production for recovery purposes would continue to operate at least until their goals are met.

4.4.1.3 Naturally Produced Salmonid Stocks

Alternative 1—No Action

Because Alternative 1 refers to effects observed from 1988 to 1993 (Baseline 1) and 1994 to 1997 (Baseline 2), effects on naturally produced salmonid stocks are discussed in relation to Alternative 2, and are summarized in Tables 4.4-5 and 4.4-6.

Alternative 2—Live Capture, Selective, and Terminal Fisheries

The natural component of Columbia Basin chinook runs ranges from 0 to 60 percent. Under Alternative 1, naturally spawning fish are harvested in approximate proportion to the percentage of the run they comprise. Under Alternative 2, for both Options A and B, mixed stock selective fisheries are implemented and analyzed using identical assumptions. Encounter rates are assumed to be the same as under Alternative 1 with all unmarked fish released. Under Option A, additional terminal fisheries are implemented in some areas. In the mixed stock selective fisheries, fishing mortality on the natural run components would be initially reduced by approximately 90 percent. Effects on naturally produced salmonid stocks under Alternative 2, Options A and B for Baselines 1 and 2 are discussed below and are summarized in Tables 4.4-5 and 4.4-6.

Lower River Fall Chinook

Approximately 26 to 30 percent of the total lower river fall chinook run (all stocks) is believed to originate from natural spawning parents. The Lewis River fall chinook stock is

Table 4.4-5. Comparison of harvest rates, incidental mortality rates, and changes in spawning escapement for key salmonid stocks in Columbia River basin fisheries under Alternatives 1, 2, and 3 for Baseline 1.

ESU or Run	Status	Alternative 1 Harvest Rate (%)	Alternative 2 Incidental Mortality Rate (%)	Increased Spawning Escapement (Alt. 1 & 2)	Alternative 3 Incidental Mortality Rate (%)	Increased Spawning Escapement (Alt. 3)
Lewis River Fall chinook (part of Lower Columbia River chinook ESU)	Threatened	38	4	55 percent (8,300)	0	61 percent (9,200)
Snake River Fall chinook	Threatened	29	3	40 percent (245)	0	45 percent (273)
Snake River Summer chinook (part of Snake River Spring/Summer ESU)	Threatened	2	0. 2	1.4 percent (36)	0	1 percent (40)
Snake River Spring chinook (part of Snake River Spring/Summer ESU)	Threatened	7	1	8 percent (418)	0	8 percent (464)
Lower Columbia River Spring chinook (includes Upper Willamette River ESU)	Threatened	52	5	99 percent (5,800)	0	106 percent (6,500)
Upriver Summer Steelhead (includes stocks from three steelhead ESUs)	Threatened/ Endangered	19	2	21 percent (10,200)	0	23 percent (11,300)
Lower Columbia River Steelhead	Threatened	6	6	No Change	0	123 (9,000)
Snake River Sockeye	Endangered	7	1	2 percent (1)	0	2 percent (1)
Columbia River Chum	Threatened	29	3	36 percent (900)	0	40 percent (1,000)

Table 4.4-6. Comparison of harvest rates, incidental mortality rates, and changes in spawning escapement for key salmonid stocks in Columbia River basin fisheries under Alternatives 1, 2, and 3 for Baseline 2.

ESU or Run	Status	Alternative 1 Harvest Rate (%)	Alternative 2 Incidental Mortality Rate (%)	Increased Spawning Escapement[1/] (Alt. 1 & 2)	Alternative 3 Incidental Mortality Rate (%)	Increased Spawning Escapement (Alt. 3)
Lewis River Fall chinook (part of Lower Columbia River chinook ESU)	Threatened	12	< 2	13 percent (1,600)	0	14 percent (1,700)
Snake River Fall chinook	Threatened	21	2	29 percent (158)	0	32 percent (176)
Snake River Summer chinook (part of Snake River Spring/Summer ESU)	Threatened	2	0.2	2 percent (36)	0	2 percent (40)
Snake River Spring chinook (part of Snake River Spring/Summer ESU)	Threatened	6	1	7 percent (88)	0	7 percent (89)
Lower Columbia River Spring chinook (includes Upper Willamette River ESU)	Threatened	43	4	69 percent (1,900)	0	75 percent (2,100)
Upriver Summer Steelhead (includes stocks from three steelhead ESUs)	Endangered	10	1	10 percent (2,800)	0	11 percent (3,100)
Lower Columbia River Steelhead	Threatened	6	6	No Change	0	121 (6,000)
Snake River Sockeye	Endangered	0	0	No Change	0	No Change
Columbia River Chum	Threatened	5	0.3	2 percent	0	3 percent (<100)

[1/] Adjusted for dam mortality.

the largest of the lower river fall chinook stocks and is used as an indicator stock. Under Alternative 2, Option B, approximately 9,200 and 1,700 unmarked fish per year would be released for Baselines 1 and 2, respectively. Escapements of wild fish to the Lewis River would increase by 8,300 and 1,600 for the respective baselines (Tables 4.4.5 and 4.4.6). Under the No Action Alternative, this stock has routinely met its escapement goal in recent years, often by a large margin.

Lower River Spring Chinook

Approximately 10 percent of lower river spring chinook (Lower River and Willamette River ESUs combined) are thought to spawn naturally (Table 4.4-1). Under Alternative 2, Option B, approximately 6,500 and 2,100 unmarked fish per year would be released for Baselines 1 and 2, respectively. Escapements of wild fish would increase by 5,800 and 1,900 for Baselines 1 and 2, respectively (Table 4.4.5 and 4.4.6).

Upriver Fall Chinook

Approximately 58 percent of fall chinook above Bonneville dam is of naturally spawning origin. Under Alternative 2, Option B, for Baseline 1, approximately 15,200, 4,500, and 34,000 unmarked fall chinook would be released in the non-Tribal commercial, non-Tribal recreational, and Tribal commercial fisheries, respectively. For Baseline 2, the number of upriver chinook released in Zones 1 through 6 would be approximately 1,200, 100, and 21,900 fish annually for non-Tribal commercial, non-Tribal recreational, and Tribal commercial fisheries, respectively (Tables 4.4.2 and 4.4.3). Resulting changes in releases will depend on how additional terminal fisheries are managed. Option A assumes that terminal fisheries will be implemented that target upriver fall chinook in the Hanford Reach area. Under the No Action Alternative, this stock has routinely met and often exceeded its escapement goal by a wide margin.

Upriver Summer Chinook

Approximately 60 percent of summer run chinook is thought to spawn in the wild. No fisheries in Zones 1 through 6 targeted summer run chinook for 1988 to 1997, and fewer than 350 fish per year were incidentally harvested in ceremonial and subsistence fisheries in Zone 6, with less than 100 fish taken annually, primarily in sport fisheries (Tables 4.4-2 and 4.4-3). Alternative 2 would reduce the average annual incidental ceremonial and subsistence mortalities to 50 fish for Baseline 1 and 140 fish for Baseline 2. Some of the released fish would augment escapement after accounting for release mortality and subsequent passage mortality through the dams.

Upriver Spring Chinook

Approximately 35 percent of the upriver spring chinook run is thought to be naturally spawning with as high as 95 percent in terminal areas. Upriver spring chinook are targeted primarily by Tribal ceremonial and subsistence fisheries in the mainstem and tributaries and by anglers in tributaries, although some were harvested in lower river commercial fisheries during the late 1980s.

Under Alternative 2, Option B there would be 3,600 and 1,500 naturally spawning fish released annually for the respective baselines. Ceremonial and subsistence fisheries in the mainstem would have released the greatest number of unmarked spring chinook (2,200 per year from 1988 to 1997).[10]

Upriver Summer Steelhead

Under Alternative 1, approximately 146,400 upriver summer steelhead would be harvested annually for Baseline 1 and 78,700 for Baseline 2. Approximately 22 percent of upriver summer steelhead (A and B runs combined) is estimated to be natural spawning (ODFW and WDFW 1998).

Recreational fishermen have been required to release unmarked steelhead under status quo management; therefore, there would be no difference between effects to recreational fisheries under Alternative 1 and Alternative 2, Option B. Commercial Tribal and mainstem ceremonial and subsistence fishermen (combined) would release 12,200 and 3,400 wild steelhead annually for Baselines 1 and 2, respectively. A significant portion of these would accrue to escapement (Tables 4.4.5 and 4.4.6).

Lower River Steelhead (Summer and Winter)

Under Alternative 1, the annual harvest of lower river steelhead would be approximately 57,900 for Baseline 1 and 38,500 for Baseline 2. Approximately 20 percent of Lower Columbia winter steelhead and 5 percent of Lower Columbia summer steelhead are thought to be of naturally spawning origin.

Nearly all harvests of lower river steelhead are made by recreational fishermen but a few are taken in Tribal commercial fisheries. Because recreational fishermen currently release all unmarked steelhead, harvests would remain unchanged under Alternative 2. The small harvests of lower river steelhead by Tribal commercial fishermen would be reduced by approximately 30 fish or less per year.

Coho Salmon

Under Alternative 1, the annual coho harvest would be 326,000 for Baseline 1 and 47,200 for Baseline 2. Approximately 10 percent of the coho salmon run is believed to originate from wild spawning parents, although in 1998 the estimated percentage of coho originating from hatcheries was much higher (Ruggerone 1999). For Baselines 1 and 2, approximately 32,600 and 4,700 unmarked naturally produced coho per year would be released, respectively.

Sockeye Salmon

An estimated one additional endangered sockeye salmon would migrate past Lower Granite Dam, representing a 2 percent increase per year. For Baseline 2, the potential increase would be less than 2 percent because total encounters of these listed salmon would decline considerably under status quo management (Alternative 1).

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10 These values may overestimate the numbers of spring chinook that would be released because some unmarked wild chinook might be retained in tributaries such as the Yakima River where the Yakama Nation has implemented a restoration program for spring chinook. Yakima River spring chinook are not listed under ESA. However, in some areas, such as the Snake River basin, harvests of some hatchery fish would not be allowed because they are important to the recovery of the listed species. These protected hatchery fish would likely remain unmarked.

Chum Salmon

Alternative 2 would allow all threatened chum salmon to be live-released and would lead to an escapement increase of up to 36 percent annually for Baseline 1 and 2 percent for Baseline 2.

Alternative 3—No Incidental Take

Cessation of salmon and steelhead fisheries in the Columbia River basin would allow the largest escapement of naturally spawning fish to occur. The net gain in spawning escapement under Alternative 3 for selected stocks is shown in Tables 4.4-5 and 4.4-6. Increased in natural escapement resulting from reduced harvest under Alternative 3 would generally not, by itself, lead to recovery unless other factors causing decline were also addressed. Other possible effects on the biota under this alternative are discussed below. This alternative would have the most drastic effect on the human environment; these are discussed in the next section.

4.4.1.4 Listed ESUs

Under Alternatives 2 and 3 more salmon and steelhead would reach the spawning grounds than they would under Alternative 1. Increases in escapement would be proportional to the reductions in harvest rate. The additional number of adults produced by these spawners is difficult to determine because of the variety of factors that control salmon and steelhead populations, especially when population levels are very low. (For a discussion of the Factors of Decline that affect the abundance of salmon stocks see Section 4.5.1, under Cumulative Effects.) The general role increased escapement can play in the recovery of most ESUs is known and, for several Columbia River chinook and steelhead ESUs (discussed below), quantitative assessments have been attempted (NMFS 2000b). These assessments indicate that, for some stocks, harvest reductions from historic levels or moratoria in and of themselves could be sufficient to reverse declining population trends (at least in the short to medium-term) and achieve self-sustaining levels. For other populations even complete harvest moratoria cannot achieve this end; however, for all populations, sustained recovery depends on setting appropriate limits on harvest but also requires substantive remedies related to the other factors for decline. The recent "All-H" paper ("H" refers to harvest, habitat, hatcheries, and hydropower), known formally as the Basin-wide Salmon Recovery Strategy, provides a conceptual recovery plan for Columbia River basin salmon and steelhead ESUs. The All-H paper integrates the requirements of the biological opinion related to the Federal Columbia River Power System (FCRPS) and adds far-reaching measures related to harvest, habitat, and hatchery operations.

Chinook Salmon

Lower Columbia River ESU

Inriver harvest rates averaged 38 percent for Baseline 1 and 12 percent for Baseline 2 under Alternative 1. Under Alternative 2, Option B incidental mortality rates would be between 1 and 4 percent. Under Alternative 3, harvest would be reduced to zero.

Upper Willamette River ESU

The Columbia River harvest rate for this ESU averaged 52 percent for Baseline 1 and 43 percent for Baseline 2 under Alternative 1. Under Alternative 2, the incidental mortality rate on wild stocks for inriver fisheries would decrease to less than 5 percent. Under Alternative 3, harvest would be reduced to zero.

Upper Columbia River Spring-run ESU

NMFS estimated the total harvest rate on this ESU at 9 percent in the 1980s and early 1990s with nearly all effects occurring inriver. The inriver harvest rate for this ESU was not modeled but, under Alternative 2, Option B it would likely be up to 1 percent. Under Alternative 3, harvest would be reduced to zero. An analysis of risk factors indicates that the declining trend of stocks in this ESU is only moderately responsive to changes in harvest effect and the stock will continue to decline at a 0 percent harvest rate unless other factors of decline are addressed (NMFS 2000).

Snake River Fall-run ESU

The loss of spawning and rearing habitat and the degradation of migration habitat are the primary reasons why this ESU was listed. Reducing fishery effects from historic levels can play a significant role in preventing further decline (NMFS 1995). Proposed de-listing criteria require 1) remedying environmental and other factors that have reduced the population to levels that are in danger of extinction and 2) the 8-year geometric mean of naturally spawning adults be 2,500 in the mainstem Snake River. Harvest reductions have been made in both ocean and inriver fisheries. The inriver harvest rate for naturally spawning chinook in this ESU was approximately 45 percent before listing (1988 to 1993), decreasing to 24 percent from 1994 to 1997. Under Alternative 2 the inriver harvest rate would be reduced to 2 to 4 percent. Under Alternative 3, harvest would be reduced to zero.

Snake River Spring/Summer-run ESU

The primary fishery effects on this run are from Tribal ceremonial and subsistence fisheries in the Columbia River, but harvest rates are extremely low (NMFS estimates total harvest rate at 6 percent [NMFS 2000b]). Under Alternative 2, fishery effects on wild fish from this ESU would be reduced to less than 1 percent. Under Alternative 3, harvest would be reduced to zero. Reductions in fishery effects can contribute to recovery but runs are predicted to decline even at zero percent exploitation unless other factors of decline are addressed (NMFS 2000b).

Steelhead

Lower Columbia River ESU

Recreational fisheries in the lower Columbia River and tributaries account for nearly all known fishing effects on this ESU. The estimated incidental mortality rate on the wild component of this run was approximately 6 percent for both Baselines 1 and 2. Because the fishery is currently managed as a mark-selective fishery, there would be no change under Alternative 2. Under Alternative 3, harvest would be reduced to zero. NMFS has estimated that a harvest rate of 10 percent or less is necessary for natural runs to be self sustaining (NMFS 2000b).

Upper Columbia River and Snake River ESUs

The combined harvest and incidental mortality rate on this ESU would be 19 percent for Baseline 1 and 10 percent for Baseline 2. Under Alternative 2 an incidental mortality rate of 1 to 2 percent would occur. Under Alternative 3, harvest would be reduced to zero.

Middle Columbia River ESU

The harvest rate on this ESU was not differentiated in the model but the relative change in mortality rate would be similar to that for the Upper Columbia River ESU. NMFS has estimated that under current habitat conditions, this ESU cannot achieve population equilibrium (even with a 0 percent harvest rate) unless other factors of decline are addressed.

Sockeye

Snake River Sockeye ESU

The combined harvest and incidental mortality rate on Snake River sockeye was 7 percent for Baseline 1 and zero percent for Baseline 2 under Alternative 1. Although there was some catch of sockeye in mainstem fisheries during the baseline years, the catches were presumably from the unlisted stocks returning to the upper Columbia River. The abundance of listed sockeye from the Snake River has been so low in recent years that the estimated catch in most years is zero. Under Alternative 2, the incidental mortality rate would be reduced 1 percent or less. Under Alternative 3, harvest would be reduced to zero.

Columbia River Chum ESU

The combined harvest rate and incidental mortality rate on Columbia Rive chum was 29 percent for Baseline 1 and 5 percent for Baseline 2 under Alternative 1. Under Alternative 2, the incidental mortality rates would have been 3 percent and less than 1 percent under the respective baselines. Under Alternative 3, there would be zero harvest.

4.4.1.5 Other Salmon Stocks

The key naturally spawning stock supporting fisheries in the Columbia River basin is upriver bright fall chinook, which spawn primarily in the Hanford Reach, upstream of Zone 6. This run declined from approximately 147,000 fish per year from 1988 to 1993 (Baseline 1) to 107,000 fish from 1994 to 1997 (Baseline 2). The corresponding harvest declined from 76,700 to 20,700 fish in response to the reduced run size but also because of greater constraints in the mainstem fisheries to reduce bycatch of wild steelhead, Snake River fall chinook, and lower river fall chinook. In spite of the reduced run size in recent years, the average annual spawning escapement of upriver bright fall chinook increased from approximately 60,000 fish annually to 64,000 fish. The spawning escapement goal has been met in all years.

Curtailment of fishing would lead to an estimated 48 percent increase in escapement beyond fisheries for Baseline 1 and a 27 percent increase for Baseline 2. The effect of these greater escapements on this stock is difficult to assess. The greater escapements may not increase future production if the current escapement level is near that which maximizes sustained harvest or production. Depending on the characteristics of the spawner-recruit curve, it is possible that exceptionally large escapements could lead to somewhat reduced future returns. Evaluation of the recruitment curve for the Columbia upriver bright component of this run is currently underway by the WDFW through sponsorship by the Chinook Technical Committee, Pacific Salmon Commission (J. Clark, ADF&G, personal communication).

4.4.1.6 Listed and Unlisted Mammalian Species

Alternative 1—No Action

Fishing activities may directly affect marine mammals through mortality caused by entanglement with fishing gear. Long-term effects include competition with fisheries for adult salmon and steelhead and harassment of marine mammals by fishermen who view harbor seals and California sea lions as competitors. Harbor seals and California sea lions primarily inhabit the Lower Columbia River (Zones 1 and 2) but California sea lions also frequent Willamette Falls where spring chinook and steelhead are especially vulnerable. Most seals and sea lions are present from late fall through early spring (NMFS 1997c) when they may be incidentally captured by commercial drift gillnets. During fall and winter 1991-1992, up to 233 harbor seals and 28 California sea lions were killed annually by gillnet fisheries (Brown and Jeffries 1993, Barlow et al. 1995). Incidental mortality of harbor seals and California sea lions has declined in recent years because of fishery reductions in the winter season designed to reduce impacts to listed salmon from the Snake River (60 FR 67063, December 28, 1995). The lower Columbia River gillnet fishery was designated as a Tier 2 – Category III fishery under amendments to the Marine Mammal Protection Act because the estimated annual mortality of harbor seals was less than 1% of the Potential Biological Removal level (PBR). Harbor seals and California sea lions consume numerous salmon and steelhead, and the increasing abundance of pinnipeds in recent years has raised concern for listed salmon and steelhead stocks (NMFS 1997c). Pinnipeds also attack fish that have been captured by nets or hook-and-line; thus fishermen, in turn, may attempt to harass seals and sea lions. Although data on these interactions are limited, the long-term effect of harassment is presumably minimal since populations of sea lions and harbor seals continue to increase.

Salmon carcasses and juvenile salmon are food sources for river otters, weasels, mink and other carnivores inhabiting riparian areas; however, the importance of salmon to these animals is largely unknown. These animals utilize a variety of prey species, including salmon when available. Removal of naturally produced salmon by fisheries, in addition to the low run sizes of most natural stocks, may have a moderate to small effect on mammal populations in localized areas, but little effect over a broad region.

The Steller sea lion is the only listed marine mammal that potentially interacts with fisheries inside the Columbia River. Interactions between gillnet fisheries and marine mammals were investigated during 1991-1992. Although several hundred Steller sea lions hauled out at the Columbia River south jetty, few did so in the lower river, and none were observed interacting with gillnet fishing, nor taken in fishing operations (Brown and Jeffries 1993).

Alternative 2—Live Capture, Selective, and Terminal Fisheries

Effects caused by entanglement were judged to be negligible with fishing methods used Under Alternative 1. Effects are likely to be less with gear types used in the mark-selective fishery because tangle nets are retrieved more frequently and because there is less chance of entanglement or other damage with beach seines, traps, weirs, etc. Increased escapement of natural salmon runs under Alternative 2 would theoretically provide more food for mammalian predators or scavengers.

Alternative 3—No Incidental Take

Effects caused by entanglement were judged to be negligible with fishing methods used under Alternative 1. Increased escapement of natural salmon runs under Alternative 3 would theoretically provide more food for mammalian predators or scavengers.

4.4.1.7 Listed and Unlisted Avian Species

Alternative 1—No Action

Short-term effects of fishing activities on avian species occur through entanglement with fishing gear. Long-term effects include alteration of food web dynamics due to fishing removals and competition with fisheries for prey. Entanglement and mortality of birds in the winter gillnet fishery in the Lower Columbia River (Zones 1 and 2) were estimated from 1991 to 1993. Approximately 0.4 percent of the drift sets contained dead birds (NMFS, unpublished data, Marine Mammal Observer Program) and approximately 45 birds were killed annually by the entire fleet fishing within Zones 1 and 2. The common murre was most frequently entangled (40 percent of total birds observed), followed by puffins (20 percent), grebes (16 percent), cormorants (12 percent), surf scoter (8 percent), and unidentified (4 percent). Although the murre population has declined during the past decade, the estimated incidental take of this species and other avian species is small compared to the total population; therefore, the effects on avian species is likely negligible.

The study indicated that most threatened marbled murrelets inhabited waters near the Columbia River mouth where no gillnet fishing occurs; no marbled murrelets were entangled or killed by fishing activities (NMFS, unpublished data, Marine Mammal Observer Program). It was determined that fisheries would not jeopardize the marbled murrelet, which is the only listed bird likely to be encountered in Lower Columbia River fisheries (J. Grettenberger, USFWS, personal communication).

Long-term effects of fishing activities on birds is difficult to quantify but it is likely small. Aquatic birds do not feed on live adult salmon in channels where fishing is likely to occur; however, gulls and possibly other birds feed on salmon carcasses and occasionally may attack live salmon in small, shallow streams. The maximum benefit to species that eat salmon carcasses or juvenile salmon would likely occur from spawning escapements that lead to maximum future returns of salmon and steelhead. This level of spawning escapement is similar to the theoretical escapement level desired by fishery managers because maximum sustained harvests theoretically occur at spawning levels slightly less than those that yield maximum adult returns (Ricker 1954). Birds may be affected to the extent that spawning escapements deviate from escapements leading to maximum salmon returns; however, birds may also switch to other prey when salmon are not abundant.

Alternative 2—Live Capture, Selective, and Terminal Fisheries and Alternative 3—No Incidental Take

Effects caused by entanglement were judged to be negligible with fishing methods used under Alternative 1. Effects are likely to be less with the gear types used in the mark-selective fishery because tangle nets are retrieved more frequently and because there is less chance of entanglement or other damage with beach seines, traps, weirs, etc. Alternatives 2 and 3 would theoretically lead to an increase in escapement of hatchery and naturally spawning salmon. Higher escapement in natural-production areas would increase food available to birds that consume salmon carcasses and the progeny of the spawning salmon.

4.4.1.8 Lower Trophic Level Species

Alternative 1—No Action

Long-term effects of fishing activity on lower trophic levels occur through the alteration of food web dynamics due to removal of adult salmon and steelhead returning to the spawning grounds. Salmon carcasses in streams provide nutrients that enhance the production of periphyton and phytoplankton, which are in turn consumed by invertebrates. Invertebrate and vertebrate species (e.g., river otters, gulls, bears, some fishes) feed directly on salmon carcasses. The maximum benefit to species that utilize salmon carcasses would likely occur from spawning escapements that lead to maximum future returns of salmon and steelhead. Invertebrate and vertebrate species may be affected to the extent that spawning escapements deviate from escapements leading to maximum salmon returns.

Alternative 2—Live Capture, Selective, and Terminal Fisheries and Alternative 3—No Incidental Take

Invertebrate and vertebrate species may be affected to the extent that spawning escapements deviate from escapements leading to maximum salmon returns.

4.4.2 Effects on the Human Environment

4.4.2.1 Introduction

This section presents an assessment of the economic and social effects for the proposed alternatives. Economic effects, including social welfare and regional economic effects, are described separately for each of the alternatives, followed by a more general discussion of the implications of economic effects for the commercial and recreational fishing communities, the port communities, and surrounding counties.

Economic effects are described for Baseline 1 (1988 to 1993) and for Baseline 2 (1994 to 1997). Potential social welfare effects associated with sport and commercial fishing for salmon are described, and regional economic effects, as represented by personal income effects on the local economy, generated by these fisheries are identified. These analyses are based on results of fishery modeling described in the previous section. For the economic analysis, the two key outputs of the fishery model are harvest and angler effort. Unlike the Southeast Alaska and Pacific Coast analyses, commercial harvests (and angler effort) associated with Alternative 1, No Action, are the same as those observed during the baselines.

4.4.2.2 Analytical Methods

Ideally, the economic analysis would evaluate differential effects of the management alternatives over time, including an assessment of the effects on stock rebuilding and the potential benefits of easing harvest restrictions associated with species listings. This type of analysis also would consider the opportunity costs associated with using resources to harvest the available stocks, and all economic effects would be evaluated at the margin. Because of limited data and many factors other than harvest management affect stock re-building, this type of dynamic analysis was not possible for this FPEIS. Alternatively, this assessment focuses on potential effects on commercial and recreational fisheries associated with short-term changes in harvest practices. Average conditions during periods of both higher and lower abundance (Baselines 1 and 2, respectively) are considered to capture some of the variability inherent in this type of "static" analysis. Potential economic and social benefits associated with moving toward recovery over the long term are discussed in Section 4.5, Cumulative Effects.

The discussions of economic effects associated with ocean sport fishing and commercial troll fishing for salmon under each alternative are separated into effects on the sum of net economic benefits produced by the national economy (i.e., social welfare effects) and effects on the distribution of net benefits among identifiable components of society. When reviewing these effects it is important to note the following:

1. Alternative 1—No Action: Because Alternative 1 serves as the baseline for the alternatives analysis, economic effects are described but are not compared to other baseline conditions or alternatives. Changes in economic effects from implementing Alternatives 2 or 3 compared to Alternative 1, are described in subsequent sections. Potential social welfare effects associated with sport fishing for salmon and commercial drift net fishing for salmon are described. In addition, regional economic effects, as represented by personal income effects on the local economy, generated by sport and commercial fisheries are identified. These analyses are based on results of fishery modeling efforts, which are described in Appendix E and summarized below. Details of the methodology for estimating the economic effects are described in Appendix D.
2. Alternative 2—Live Capture, Selective, and Terminal Fisheries: Under Alternative 2, two options are evaluated. Option A allows for harvesting of these surpluses in areas where the abundance of listed species is exceptionally low. Option B is a more restrictive approach to implementing mark-selective fisheries in which surpluses of naturally spawning (unmarked) fish cannot be harvested. Effects under Alternative 2, compared to Alternative 1, are described for Baselines 1 and 2. Details of the methodology for estimating the economic effects are described in Appendix D.
3. One kind of distributional effect is estimated by a regional economic analysis. This approach is used to estimate the expected changes in economic activity within a

specific geographic region resulting from the adoption of specific alternatives. The region is specified to cover the area where changes are expected to be concentrated. From the society-as-a-whole perspective, partially offsetting changes occurs outside the specified region, but they are not included in this analysis.

For the purposes of this analysis the economic parameter used to evaluate the social welfare effects of changes in ocean sport fishing for salmon is angler benefits (i.e., net WTP for ocean salmon fishing). For commercial troll fishing for salmon the parameter used to evaluate social welfare effects is the net income (profit) to commercial troll fishers associated with changes in the ex-vessel value of the salmon harvested, including chinook, coho, sockeye, chum, and pink salmon. This net income approximates producer surplus and nets out operating costs, which are measured by the opportunity costs of resources being diverted into the fish production process. As discussed in Appendix D, changes in the commercial harvest of salmon are also expected to have consumer surplus effects but these effects could not be reliably quantified for this analysis. The parameters used to measure distributional effects from changes in ocean sport and troll fishing for salmon are the direct personal income contribution to the commercial fishing industry and to businesses that sell goods and services to sport anglers within specific boroughs, and changes in net income to businesses that are directly affected by angler activity.

The analysis of economic effects in the Columbia River basin focused on changes in counties in Washington, Oregon, and Idaho that are adjacent to the Columbia River. The details of the methodology employed to estimate economic effects within the Columbia River basin are described in Appendix D. The following sections summarize this methodology.

Social Welfare Effects

Sport Fishing

For each alternative estimates of angler days were developed for salmon and steelhead fishing by county of destination in Washington, Oregon, and Idaho. For Alternative 1 and Alternative 2, Option B, the number of trips were derived using the observed average annual catch divided by the observed average annual catch-per-unit-of-effort during each baseline (1988 through 1993 and 1994 through 1997). Under Alternative 2, Option A, the predicted sport catch of hatchery fish was divided by the observed catch-per-unit-of-effort during each baseline to estimate effort (angler days). Angler days were developed for seven counties and one four-county region in Washington, five counties and one three-county region in Oregon, and three counties and one three-county region in Idaho. Angler days also were identified for other, unspecified counties of destination in Oregon and Washington. This information was used to quantify angler spending, net income to sport fishing-related businesses, and net benefits to salmon and steelhead anglers.

The net benefits to anglers, as measured by their net WTP for salmon fishing opportunities, were estimated based on average per-angler-day values for sport fishing on the Snake River, as reported by the United States Army Corps of Engineers (1999). From this study, an average value of $34 per trip (in 1996 dollars) for sport fishing for salmon and steelhead was derived and applied to the predicted number of angler trips.

Commercial Fishing

Estimates of the number of fish harvested in the chinook, coho, and chum/sockeye fishery along the Columbia River were developed based on observed data for Baselines 1 and 2. These data were used to characterize harvest under Alternative 1. For Alternative 2, Option A, harvest levels under Alternative 1 were adjusted to reflect the proportion of wild fish that would have to be released to meet the incidental take requirements. For Alternative 2, Option B, status quo harvest levels under Alternative 1 were adjusted to fully utilize hatchery stocks (i.e., harvest as much of the hatchery stocks while still meeting hatchery escapement goals). Based on anecdotal information from the Oregon Department of Fish and Wildlife, the estimates of harvest were allocated to different ports. Harvest levels were then used to estimate ex-vessel value and net income (profits) to commercial salmon fishers by county.

The estimated harvest of chinook, coho, and chum/sockeye salmon by port were combined at the county level. The ex-vessel value of the harvest was then calculated based on average prices per pound, which were derived from 1997 Council data for the non-Tribal gillnet for the Oregon side of the Columbia River (refer to Appendix D for prices). A net income coefficient of 0.40, derived from proprietary income data for West Coast regions in the 1992 IMPLAN database, was applied to predicted ex-vessel revenues for each county to arrive at net income generated for commercial salmon fishers (refer to Appendix D for a comparison of net income coefficients employed by other fishery economic studies). As indicated above, changes in consumer surplus could not be quantified for the analysis but are discussed in Appendix D.

Distributional Effects

Sport Fishing for Salmon and Steelhead

Total (direct, indirect, and induced) personal income generated by salmon angler spending was estimated based on personal income multipliers applied to the predicted number of angler days for salmon and steelhead. A multiplier of $31.30 per angler day (in 1996 dollars), derived from information in a 1991 study by The Research Group, was used to estimate total personal income effects.

It should be noted that the analytical procedures used to estimate total personal income effects do not differentiate between spending by resident and nonresident anglers. From a local or regional economic effects perspective, this distinction is important because spending by anglers who live outside the region of interest represents “new” income to the region, whereas spending by residents of the region is primarily income that is re-directed from other activities within the region. This distinction could not be accurately accounted for in the analysis because of limited data on the relative proportion of resident and nonresident anglers and on spending patterns of resident anglers. The effect on the analysis of not accounting for this is that the estimates of changes in direct personal income are overstated, probably by 20 to 30 percent.

Angler spending on sport fishing for salmon was estimated based on spending profiles developed using information from a 1991 study by The Research Group on sport fishing activity in Oregon. A per-angler-day spending estimate of $47.88 (in 1996 dollars) was derived by averaging spending profiles for resident and nonresident anglers for sport fishing in the Columbia River basin region. The per-day spending profiles were multiplied by the predicted angler days to estimate total spending associated with sport fishing. The net income received by affected sport fishing-related businesses was estimated based on a net income coefficient of 0.116, which was derived from data on proprietary income in the 1992 IMPLAN database. This coefficient was applied to estimated sport fishing-related spending to estimate net income for affected businesses (refer to Appendix D for more discussion of how the net income coefficient was derived).

Commercial Fishing

Total (direct, indirect, and induced) personal income generated by commercial fishing for salmon at the county level was estimated based on personal income multipliers applied to the estimated ex-vessel value of the chinook and coho harvest. These multipliers (1.15 for chinook and 1.319 for coho) were obtained from the Council (Seger personal communication). The multipliers were originally derived from information compiled for the Fishery Economic Assessment Model developed by The Research Group (1991).

The income effects on processors are included in the estimates of local income effects. The percentage of local income attributable to processors varies by location, species harvested, and type of gear used for harvesting. Based on information from the Fishery Economic Assessment Model developed by The Research Group, processors account 65 percent of the local income generated by net fishing for coho, and about 85 percent of the local income generated by net fishing for chinook.

4.4.2.3 Social Welfare Effects

Sport Fishing

Alternative 1—No Action

The analysis of sport fishing for salmon and steelhead focuses on social welfare effects associated with predicted angler days. The economic parameter used to evaluate these effects is angler benefits (i.e., net WTP for ocean salmon fishing). The number of predicted angler days for salmon and steelhead by county of destination under Alternative 1 is shown in Table 4.4-7 for Baseline 1. The number of angler days includes all modes of fishing. As shown, counties in the State of Washington would account for 943,000 salmon and steelhead angler days and approximately $32.1 million in angler benefits, or approximately 50 percent of angler days and benefits within the region. Oregon counties would account for approximately 46 percent of regionwide angler days and benefits, and Idaho counties would account for approximately 4 percent of the total. In the State of Washington, Cowlitz County accounts for approximately 23 percent of statewide angler days and benefits. In Oregon, Clackamas is the most important destination county for sport fishing for salmon and steelhead along the Lower Columbia River and tributaries, accounting for approximately 35 percent of angler days and benefits under Alternative 1. Idaho County in Idaho State accounts for more than 44 percent of all angler days and benefits associated with sport fishing for salmon and steelhead along the Lower Columbia River (and tributaries) in Idaho.

For Baseline 2, predicted angler days and angler benefits are shown in Table 4.4-8. For Baseline 2, fishing effort decreases substantially. Regionwide, the number of angler days and benefits associated with sport fishing for salmon and steelhead is predicted to decrease by nearly 1.1 million angler days and $36.4 million, respectively, a decrease of approximately 58 percent compared to Baseline 1. Angler benefits would decrease by $17.5 million in Washington, $18.0 million in Oregon, and $864,000 in Idaho.

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option A

The number of predicted angler days for salmon and steelhead under Alternative 2, Option A, is shown in Table 4.4-7 for Baseline 1. As shown, counties of destination in Washington would account for approximately 1.2 million angler days for salmon and steelhead and $39.7 million in angler benefits (52 percent of salmon angler days and benefits regionwide). This compares to a 51 percent share of regionwide angler trips and benefits under Alternative 1. Angler days and benefits are predicted to increase by approximately 24 percent compared to Alternative 1. Anglers fishing for salmon and steelhead out of ports in Cowlitz County would receive an additional $2.0 million in benefits, an increase of approximately 27 percent.

Oregon counties of destination would account for 988,200 angler days and approximately $33.6 million in angler benefits (44 percent of regionwide trips and benefits). This compares to a 45 percent share of regionwide angler days and benefits under Alternative 1. Angler days and benefits are predicted to increase by 17 percent compared to Alternative 1. Anglers fishing for salmon and steelhead out of ports in Clackamas County would receive approximately $10.6 million in benefits.

Counties of destination in Idaho would account for 82,200 angler days and approximately $2.8 million in angler benefits (4 percent of regionwide angler days and benefits). Idaho State's regionwide share of angler days and benefits is also 4 percent under Alternative 1. Angler days and benefits are predicted to increase by 14 percent compared to Alternative 1. Anglers fishing for salmon and steelhead out of ports in Idaho County would receive an additional $153,000 in benefits.

For Baseline 2, predicted angler days and angler benefits for Alternative 2, Option B, are shown in Table 4.4-8. Regionwide, angler benefits would increase by approximately $16.3 million (61 percent). In Washington angler benefits would increase from zero percent in Skamania and Clark Counties to 109 percent in Pacific County (angler benefits would increase by an estimated 136 percent in unspecified counties). In Oregon angler benefits would increase from zero percent in Linn County to 66 percent in Clatsop County. In Idaho State angler benefits would increase by approximately 65 percent in all affected counties.

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option B

The number of predicted angler days for salmon and steelhead under Alternative 2, Option B, is shown in Table 4.4-7 for Baseline 1. As shown, counties of destination in Washington would account for approximately 885,000 angler days for salmon and steelhead and $30.1 million in angler benefits (5 percent of salmon angler days and benefits regionwide). Angler days and benefits statewide would be similar to those under

Table 4.4-7. Net economic values for sport fishing in the Columbia River basin under Alternatives 1 and 2 for Baseline 1.

	Alternative 1			Alternative 2, Option A							Alternative 2, Option B						
					Angler Benefits[1/]			Net Income to Businesses[1/]				Angler Benefits[1/]			Net Income to Businesses[1/]		
State/County	**Angler Days**	**Angler Benefits**	**Net Income to Businesses**	**Angler Days**	**Value**	**Change**	**% Change**	**Value**	**Change**	**% Change**	**Angler Days**	**Value**	**Change**	**% Change**	**Value**	**Change**	**% Change**
Washington																	
Pacific	107,000	$3,638,000	$594,287	153,900	$5,232,600	$1,594,600	44	$854,773	$260,486	44	93,700	$3,185,800	($452,200)	12	$520,417	($73,870)	12
Wahkiakum	31,700	$1,077,800	$176,064	39,800	$1,353,200	$275,400	26	$221,052	$44,988	26	29,300	$996,200	($81,600)	8	$162,735	($13,329)	8
Cowlitz	217,300	$7,388,200	$1,206,902	275,600	$9,370,400	$1,982,200	27	$1,530,704	$323,802	27	199,400	$6,779,600	($608,600)	8	$1,107,484	($99,418)	8
Clark	53,300	$1,812,200	$296,032	53,300	$1,812,200	$0	0	$296,032	$0	0	53,300	$1,812,200	$0	0	$296,032	$0	0
Lewis	184,500	$6,273,000	$1,024,728	222,400	$7,561,600	$1,288,600	21	$1,235,227	$210,499	21	172,900	$5,878,600	($394,400)	6	$960,300	($64,428)	6
Skamania	24,900	$846,600	$138,297	24,900	$846,600	$0	0	$138,297	$0	0	24,900	$846,600	$0	0	$138,297	$0	0
Klickitat	129,800	$4,413,200	$720,920	160,600	$5,460,400	$1,047,200	24	$891,985	$171,065	24	123,900	$4,212,600	($200,600)	5	$688,151	($32,769)	5
Benton/Yakima/Franklin/ Chelan	173,100	$5,885,400	$961,411	205,000	$6,970,000	$1,084,600	18	$1,138,586	$177,175	18	168,700	$5,735,800	($149,600)	3	$936,973	($24,438)	3
Unspecified	21,400	$727,600	$118,857	31,700	$1,077,800	$350,200	48	$176,064	$57,207	48	18,500	$629,000	($98,600)	14	$102,750	($16,107)	14
STATE TOTAL	**943,000**	**$32,062,000**	**$5,237,498**	**1,167,200**	**$39,684,800**	**$7,622,800**	**24**	**$6,482,720**	**$1,245,222**	**24**	**884,600**	**$30,076,400**	**($1,985,600)**	**6**	**$4,913,139**	**($324,359)**	**6**
Oregon																	
Clatsop	109,100	$3,709,400	$605,950	129,600	$4,406,400	$697,000	19	$719,809	$113,859	19	95,600	$3,250,400	($459,000)	12	$530,970	($74,980)	12
Columbia	48,600	$1,652,400	$269,928	51,000	$1,734,000	$81,600	5	$283,258	$13,330	5	42,700	$1,451,800	($200,600)	12	$237,159	($32,769)	12
Multnohmah	76,800	$2,611,200	$426,553	80,100	$2,723,400	$112,200	4	$444,882	$18,329	4	68,600	$2,332,400	($278,800)	11	$381,010	($45,543)	11
Clackamas	295,500	$10,047,000	$1,641,231	311,700	$10,597,800	$550,800	5	$1,731,207	$89,976	5	255,500	$8,687,000	($1,360,000)	14	$1,419,067	($222,164)	14
Linn	18,600	$632,400	$103,306	18,600	$632,400	$0	0	$103,306	$0	0	18,600	$632,400	$0	0	$103,306	$0	0
Hood River/Wasco/Sherman	166,400	$5,657,600	$924,199	185,000	$6,290,000	$632,400	11	$1,027,505	$103,306	11	164,200	$5,582,800	($74,800)	1	$911,980	($12,219)	1
Unspecified	128,400	$4,365,600	$713,144	212,200	$7,214,800	$2,849,200	65	$1,178,576	$465,432	65	118,200	$4,018,800	($346,800)	8	$656,492	($56,652)	8
STATE TOTAL	**843,400**	**$28,675,600**	**$4,684,311**	**988,200**	**$33,598,800**	**$4,923,200**	**17**	**$5,488,543**	**$804,232**	**17**	**763,400**	**$25,955,600**	**($2,720,000)**	**9**	**$4,239,984**	**($444,327)**	**9**
Idaho																	
Idaho	32,000	$1,088,000	$177,731	36,500	$1,241,000	$153,000	14	$202,724	$24,993	14	32,000	$1,088,000	$0	0	$177,731	$0	0
Nez Perce	18,500	$629,000	$102,750	21,100	$717,400	$88,400	14	$117,191	$14,441	14	18,500	$629,000	$0	0	$102,750	$0	0
Valley	7,200	$244,800	$39,989	8,200	$278,800	$34,000	14	$45,543	$5,554	14	7,200	$244,800	$0	0	$39,989	$0	0
Lemhi/Custer/Clearwater	14,400	$489,600	$79,979	16,400	$557,600	$68,000	14	$91,087	$11,108	14	14,400	$489,600	$0	0	$79,979	$0	0
STATE TOTAL	**72,100**	**$2,451,400**	**$400,449**	**82,200**	**$2,794,800**	**$343,400**	**14**	**$456,545**	**$56,096**	**14**	**72,100**	**$2,451,400**	**$0**	**0**	**$400,449**	**$0**	**0**
REGION TOTAL	**1,858,500**	**$63,189,000**	**$10,322,258**	**2,237,600**	**$76,078,400**	**$12,889,400**	**20**	**$12,427,808**	**$2,105,550**	**20**	**1,720,100**	**$58,483,400**	**($4,705,600)**	**7**	**$9,553,572**	**($768,686)**	**7**

Notes:
1/ Change and % change for angler benefits and net income to businesses are in relation to Alternative 1—No Action.
Angler benefits are estimated based on an average value of $34 per angler day, as derived by Corps (1999) for angling on the Snake River.
Net income to businesses is estimated at 11.6 percent of angler spending and was derived from information on proprietary income from IMPLAN. A weighted (based on proportionate spending) average from the following sectors was used: food stores, food and beverage establishments, service stations and fuel, lodging, and miscellaneous retail trade.
All monetary values are in constant 1996 dollars.
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

Table 4.4-8. Net economic values for sport fishing in the Columbia River basin under the Alternatives 1 and 2 for Baseline 2.

	Alternative 1			Alternative 2, Option							Alternative 2, Option B						
					Angler Benefits[1/]			Net Income to Businesses[1/]				Angler Benefits[1/]			Net Income to Businesses[1/]		
State/County	**Angler Days**	**Angler Benefits**	**Net Income to Businesses**	**Angler Days**	**Value**	**Change**	**% Change**	**Value**	**Change**	**% Change**	**Angler Days**	**Value**	**Change**	**% Change**	**Value**	**Change**	**% Change**
Washington																	
Pacific	30,000	$1,020,000	$166,622	62,800	$2,135,200	$1,115,200	109	$348,796	$182,174	109	27,100	$921,400	($98,600)	10	$150,516	($16,106)	10
Wahkiakum	13,900	$472,600	$77,202	21,800	$741,200	$268,600	57	$121,079	$43,877	57	13,500	$459,000	($13,600)	3	$74,980	($2,222)	3
Cowlitz	100,800	$3,427,200	$559,851	164,600	$5,596,400	$2,169,200	63	$914,202	$354,351	63	97,900	$3,328,600	($98,600)	3	$543,744	($16,107)	3
Clark	27,100	$921,400	$150,516	27,100	$921,400	$0	0	$150,516	$0	0	27,100	$921,400	$0	0	$150,516	$0	0
Lewis	87,200	$2,964,800	$484,316	128,300	$4,362,200	$1,397,400	47	$712,588	$228,272	47	85,300	$2,900,200	($64,600)	2	$473,763	($10,553)	2
Skamania	12,700	$431,800	$70,537	12,700	$431,800	$0	0	$70,537	$0	0	12,700	$431,800	$0	0	$70,537	$0	0
Klickitat	61,800	$2,101,200	$343,242	113,900	$3,872,600	$1,771,400	84	$632,610	$289,368	84	60,900	$2,070,600	($30,600)	1	$338,243	($4,999)	1
Benton/Yakima/Franklin/Chelan	83,900	$2,852,600	$465,987	145,900	$4,960,600	$2,108,000	74	$810,340	$344,353	74	83,200	$2,828,800	($23,800)	1	$462,099	($3,888)	1
Unspecified	9,400	$319,600	$52,208	22,200	$754,800	$435,200	136	$123,301	$71,093	136	8,900	$302,600	($17,000)	5	$49,431	($2,777)	5
STATE TOTAL	**426,800**	**$14,511,200**	**$2,370,481**	**699,300**	**$23,776,200**	**$9,265,000**	**64**	**$3,883,969**	**$1,513,488**	**64**	**416,600**	**$14,164,400**	**($346,800)**	**2**	**$2,313,829**	**($56,652)**	**2**
Oregon																	
Clatsop	31,900	$1,084,600	$177,175	52,900	$1,798,600	$714,000	66	$293,811	$116,636	66	28,700	$975,800	($108,800)	10	$159,402	($17,773)	10
Columbia	17,000	$578,000	$94,419	25,400	$863,600	$285,600	49	$141,074	$46,655	49	15,600	$530,400	($47,600)	8	$86,644	($7,775)	8
Multnohmah	28,500	$969,000	$158,291	40,100	$1,363,400	$394,400	41	$222,719	$64,428	41	26,600	$904,400	($64,600)	7	$147,739	($10,552)	7
Clackamas	98,300	$3,342,200	$545,966	155,200	$5,276,800	$1,934,600	58	$861,993	$316,027	58	88,900	$3,022,600	($319,600)	10	$493,758	($52,208)	10
Linn	9,500	$323,000	$52,764	9,500	$323,000	$0	0	$52,764	$0	0	9,500	$323,000	$0	0	$52,764	$0	0
Hood River/Wasco/Sherman	79,800	$2,713,200	$443,216	128,800	$4,379,200	$1,666,000	61	$715,366	$272,150	61	79,300	$2,696,200	($17,000)	1	$440,439	($2,777)	1
Unspecified	49,700	$1,689,800	$276,038	79,200	$2,692,800	$1,003,000	59	$439,883	$163,845	59	47,300	$1,608,200	($81,600)	5	$262,708	($13,330)	5
STATE TOTAL	**314,700**	**$10,699,800**	**$1,747,869**	**491,100**	**$16,697,400**	**$5,997,600**	**56**	**$2,727,610**	**$979,741**	**56**	**295,900**	**$10,060,600**	**($639,200)**	**6**	**$1,643,454**	**($104,415)**	**6**
Idaho																	
Idaho	20,700	$703,800	$114,969	34,100	$1,159,400	$455,600	65	$189,394	$74,425	65	20,700	$703,800	$0	0	$114,969	$0	0
Nez Perce	12,000	$408,000	$66,649	19,700	$669,800	$261,800	64	$109,415	$42,766	64	12,000	$408,000	$0	0	$66,649	$0	0
Valley	4,700	$159,800	$26,104	7,700	$261,800	$102,000	64	$42,766	$16,662	64	4,700	$159,800	$0	0	$26,104	$0	0
Lemhi/Custer/Clearwater	9,300	$316,200	$51,653	15,400	$523,600	$207,400	66	$85,533	$33,880	66	9,300	$316,200	$0	0	$51,653	$0	0
STATE TOTAL	**46,700**	**$1,587,800**	**$259,375**	**76,900**	**$2,614,600**	**$1,026,800**	**65**	**$427,108**	**$167,733**	**65**	**46,700**	**$1,587,800**	**$0**	**0**	**$259,375**	**$0**	**0**
REGION TOTAL	**788,200**	**$26,798,800**	**4,377,725**	**1,267,300**	**$43,088,200**	**$16,289,400**	**61**	**7,038,687**	**$2,660,962**	**61**	**759,200**	**$25,812,800**	**($986,000)**	**4**	**4,216,658**	**($161,067)**	**4**

Notes:
1/ Change and % change for angler benefits and net income to businesses are in relation to Alternative 1—No Action.
Angler benefits are estimated based on an average value of $34 per angler day, as derived by Corps (1999) for angling on the Snake River.
Net income to businesses is estimated at 11.6 percent of angler spending and was derived from information on proprietary income from IMPLAN. A weighted (based on proportionate spending) average from the following sectors was used: food stores, food and beverage establishments, service stations and fuel, lodging, and miscellaneous retail trade.
All monetary values are in constant 1996 dollars.
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

Alternative 1. Within individual counties, angler days and benefits would be reduced by 3 to 12 percent (no change would occur in Clark and Skamania counties). Oregon counties of destination would account for 763,400 angler days and about $26.7 million in angler benefits (44 percent of regionwide trips and benefits). This share would be similar to the regional share under Alternative 1. Within individual counties, angler days and benefits would be reduced by 1 to 14 percent (no change would occur in Linn County). Compared to Alternative 1, angler days and benefits would substantially increase in unspecified counties, which could offset the predicted adverse effects in the Oregon counties.

Counties of destination in Idaho would account for 72,100 angler days and approximately $2.5 million in angler benefits (4 percent of regionwide angler days and benefits). Idaho's regionwide share of angler days and benefits was also 4 percent under Alternative 1. Angler days and benefits are not expected to change compared to Alternative 1. Approximately 44 percent of the angler days and benefits would occur in Idaho County.

For Baseline 2, predicted angler days and angler benefits under Alternative 2, Option B, are shown in Table 4.4-8. Regionwide, angler benefits are expected to be similar to benefits under Alternative 1. Statewide levels of angler benefits are also expected to remain similar, although inter-county shares of angler benefits may shift in Washington and Oregon (Table 4.4-8).

Alternative 3—No Incidental Take

Under Alternative 3, there would be no sport fishing for salmon and steelhead in the Lower Columbia River. The effect of this alternative would be to forego the economic effects of sport fishing for salmon and steelhead generated under Alternative 1, which are shown in Tables 4.4-7 and 4.4-8. Under Alternative 3, anglers would forego the benefits associated with sport fishing for salmon and steelhead in the Lower Columbia River under Alternative 1, which are estimated to be approximately $63.2 million regionwide based on 1.9 million angler trips (Table 4.4-7). Anglers from Washington, Oregon, and Idaho ports would forego approximately $32.1 million, $28.7 million, and $2.5 million in annual benefits, respectively. Annual benefits foregone include $10.0 million by salmon and steelhead anglers from Clackamas County in Oregon, approximately $7.4 million by anglers from Cowlitz County in Washington, and approximately $5.7 million by anglers from the three-county area of Hood River/Wasco/Sherman in Oregon. Sport fishing for species other than salmon and steelhead may recapture some of the foregone angler benefits.

For Baseline 2, anglers would forego approximately $26.8 million in angler benefits regionwide. Washington, Oregon, and Idaho anglers would forego approximately $14.5 million, $10.7 million, and $1.6 million in annual benefits, respectively (Table 4.4-8). As indicated above, some of the foregone angler benefits may be recaptured by sport fishing for species other than salmon.

Commercial Fishing

The analysis of commercial drift gillnet fishing for salmon focuses on the social welfare effects associated with the ex-vessel value of the salmon harvest including chinook, coho, and minor catches of chum and sockeye salmon. The economic parameter used to evaluate these effects is the net income (profit) to commercial fishers. Idaho is not included in this discussion because there is no commercial fishing in Idaho.

Alternative 1—No Action

The ex-vessel value and net income to commercial drift gillnet fishers for salmon on the Lower Columbia River under Alternative 1 is shown in Table 4.4-9 for Baseline 1. It is assumed that Washington and Oregon counties would each account for 50 percent of the $1.8 million in ex-vessel value and $705,500 in net income to commercial fishers. Pacific County, Washington, and Clatsop County, Oregon, would each account for approximately $265,000 in net income (approximately 75 percent of the state total.). Table 4.4-10 shows ex-vessel value and net income to commercial fishers for Baseline 2 when the abundance of salmon available for commercial harvest was much lower.

Regionwide, the ex-vessel value and net income to commercial fishers generated by drift gillnet fishing for salmon is estimated to be approximately $210,000 and $84,000, respectively, or approximately 88 percent lower compared to Baseline 1.

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option A

The ex-vessel value and net income to commercial fishers of drift gillnet-caught salmon under Alternative 2, Option A, are shown in Table 4.4-9 for Baseline 1. Similar to the Alternative 1, it is assumed that counties in Washington and Oregon would each account for 50 percent of the ex-vessel value and net income to commercial fishers under Alternative 2, Option A. Regionwide, net income to commercial salmon anglers is predicted to decrease by approximately $53,300; counties in Washington and Oregon would equally share the loss. Commercial salmon fishers in Washington's Pacific County and Oregon's Clatsop County would each experience a loss of approximately $20,000 in net income.

For Baseline 2, the ex-vessel value and net income to commercial salmon fishers under Alternative 2, Option A, are shown in Table 4.4-10. Regionwide, the ex-vessel value of the salmon harvest would increase by approximately $40,800 and the net income to commercial salmon fishers would increase by approximately $16,300 compared to Alternative 1 (an increase of 19 percent). Port counties in Washington and Oregon are expected to equally share the gain in net income to commercial salmon fishers, with Pacific County, Washington, and Clatsop County, Oregon, each experiencing a net income gain of approximately $6,100.

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option B

The ex-vessel value and net income to commercial drift gillnet fishers for salmon under Alternative 2, Option B, are shown in Table 4.4-9 for Baseline 1. Similar to Alternative 1, it is assumed that counties in Washington and Oregon would each account for 50 percent of the ex-vessel value and net income to commercial fishers under Alternative 2, Option B. Regionwide, net income to commercial salmon anglers is predicted to decrease by approximately $168,000; counties in Washington and Oregon would equally share the loss. Commercial salmon fishers in Washington's Pacific County and Oregon's Clatsop County would each experience a loss of approximately $63,000 in net income.

For Baseline 2, the ex-vessel value and net income to commercial salmon fishers under Alternative 2, Option B, are shown in Table 4.4-10. Regionwide, the ex-vessel value of the salmon harvest would decrease by approximately $40,700 and the net income to

Table 4.4-9. Net income for commercial fishing in the Columbia River basin under Alternatives 1 and 2 for Baseline 1.

	Alternative 1		Alternative 2, Option A				Alternative 2, Option B			
				Net Income to Commercial Drift[2/]				Net Income to Commercial Drift[2/]		
State/County	**Ex-Vessel Value**	**Net Income to Commercial Drift Gillnet Fishers**	**Ex-Vessel Value**	**Value**	**Change**	**% Change**	**Ex-Vessel Value**	**Value**	**Change**	**% Change**
Washington										
Pacific	$661,390	$264,556	$611,437	$244,575	($19,981)	(8)	$504,272	$201,709	($62,847)	(24)
Wahkiakum	$88,185	$35,274	$81,525	$32,610	($2,664)	(8)	$67,236	$26,894	($8,380)	(24)
Cowlitz	$88,185	$35,274	$81,525	$32,610	($2,664)	(8)	$67,236	$26,894	($8,380)	(24)
Clark	$44,093	$17,637	$40,762	$16,305	($1,332)	(8)	$33,618	$13,447	($4,190)	(24)
STATE TOTAL	**$881,853**	**$352,741**	**$815,249**	**$326,100**	**($26,642)**	**(8)**	**$672,362**	**$268,945**	**($83,796)**	**(24)**
Oregon										
Clatsop	$661,390	$264,556	$611,437	$244,575	($19,981)	(8)	$504,272	$201,709	($62,847)	(24)
Columbia	$176,371	$70,548	$163,050	$65,220	($5,328)	(8)	$134,372	$53,749	($16,800)	(24)
Multnohmah	$44,093	$17,637	$40,762	$16,305	($1,332)	(8)	$33,618	$13,447	($4,190)	(24)
STATE TOTAL	**$881,854**	**$352,742**	**$815,249**	**$326,100**	**($26,642)**	**(8)**	**$672,262**	**$268,905**	**($83,837)**	**(24)**
REGION TOTAL[1/]	**$1,763,707**	**$705,483**	**$1,630,498**	**$652,199**	**($53,284)**	**(8)**	**$1,344,624**	**$537,850**	**($167,633)**	**(24)**

Notes:
1/ Region total consists of Washington and Oregon only because there is no commercial fishing in Idaho.
2/ Change and % for net income to Commercial Drift are in relation to Alternative 1.
Net income to commercial fishers is estimated at 40 percent of the ex-vessel value based on information from IMPLAN on proprietary income as a percent of ex-vessel value for the commercial fishing sector in Oregon.
All monetary values are in constant 1996 dollars.
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

Table 4.4-10. Net income for commercial fishing in the Columbia River basin under Alternatives 1 and 2 for Baseline 2.

	Alternative 1		Alternative 2, Option A				Alternative 2, Option B			
				Net Income to Commercial Drift				Net Income to Commercial Drift		
State/County	**Ex-Vessel Value**	**Net Income to Commercial Drift Gillnet Fishers**	**Ex-Vessel Value**	**Value**	**Change**	**% Change**	**Ex-Vessel Value**	**Value**	**Change**	**% Change**
Washington										
Pacific	$78,733	$31,493	$94,029	$37,612	$6,118	19	$63,467	$25,387	($6,106)	(19)
Wahkiakum	$10,498	$4,199	$12,537	$5,015	$816	19	$8,462	$3,385	($814)	(19)
Cowlitz	$10,498	$4,199	$12,537	$5,015	$816	19	$8,462	$3,385	($814)	(19)
Clark	$5,249	$2,100	$6,269	$2,508	$408	19	$4,231	$1,692	($407)	(19)
STATE TOTAL	**$104,978**	**$41,991**	**$125,372**	**$50,149**	**$8,158**	**19**	**$84,622**	**$33,849**	**($8,142)**	**(19)**
Oregon										
Clatsop	$78,733	$31,493	$94,029	$37,612	$6,118	19	$63,467	$25,387	($6,106)	(19)
Columbia	$20,996	$8,398	$25,074	$10,030	$1,631	19	$16,925	$6,770	($1,628)	(19)
Multnohmah	$5,249	$2,100	$6,269	$2,508	$408	19	$4,231	$1,692	($407)	(19)
STATE TOTAL	**$104,978**	**$41,991**	**$125,372**	**$50,149**	**$8,158**	**19**	**$84,623**	**$33,849**	**($8,142)**	**(19)**
REGION TOTAL[1/]	**$209,956**	**$83,982**	**$250,744**	**$100,298**	**$16,315**	**19**	**$169,245**	**$67,698**	**($16,284)**	**(19)**

Notes:
1/ Region total consists of Washington and Oregon only because there is no commercial fishing in Idaho.
2/ Change and % for net income to Commercial Drift are in relation to Alternative 1.
Net income to commercial fishers is estimated at 40 percent of the ex-vessel value based on information from IMPLAN on proprietary income as a percent of ex-vessel value for the commercial fishing sector in Oregon.
All monetary values are in constant 1996 dollars.
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

commercial salmon fishers would decrease by approximately $16,300 compared to Alternative 1 (a decrease of approximately 19 percent). Port counties in Washington and Oregon are expected to equally share the loss in net income to commercial salmon fishers, with Pacific County, Washington, and Clatsop County, Oregon, each experiencing a net income loss of approximately $6,100.

Alternative 3—No Incidental Take

Under Alternative 3, there would be no commercial fishing for salmon in the Lower Columbia River. The effect of this alternative would be to forego the economic effects of commercial salmon fishing generated under Alternative 1, which are shown in Table 4.4-9 for Baseline 1. Under Alternative 3, commercial salmon fishers would forego the net income associated with drift gillnet fishing for salmon under Alternative 1, which are estimated regionwide to be $705,500 based on an ex-vessel value of $1.8 million (Table 4.4-9). Commercial salmon fishers from Washington and Oregon ports would each forego approximately $352,700 in net income.

For Baseline 2, commercial salmon fishers would forego approximately $84,000 in net income regionwide, with Washington and Oregon commercial fishers each foregoing $42,000 in annual net income.

Consumers of Salmon

All Alternatives

As discussed in Appendix D, changes in the commercial harvest of salmon are also expected to have consumer surplus effects, but these effects could not be reliably quantified for this analysis.

4.4.2.4 Distributional Effects

Alternative 1—No Action

The analysis of distributional effects focuses on the personal income contribution to the local economy generated by sport fishing for salmon and steelhead and by commercial drift gillnet fishing for salmon. The local economy is defined as counties where key sport and commercial fishing ports are located. Total personal income consists of employee compensation and property income, which includes proprietary income (i.e., profits from self-employment) and other property income such as rental income, dividends, and corporate profits.

The personal income effects generated by sport fishing for salmon and steelhead and commercial drift gillnet fishing for salmon under Alternative 1 are shown in Table 4.4-11 for Baseline 1. As shown, sport and commercial fishing for salmon generates approximately $29.5 million in personal income in counties in the State of Washington; Cowlitz County accounts for the largest contribution to local personal income ($6.9 million). Sport and commercial fishing for salmon in Oregon counties generates approximately $26.4 million in personal income; Clackamas County accounts for approximately 35 percent of the local income effects. In Idaho, Idaho County accounts for

$1.0 million of the $2.3 million generated by sport fishing activity along the Lower Columbia River and tributaries.

For Baseline 2, local personal income generated by sport fishing for salmon and steelhead and by commercial fishing for salmon is shown in Table 4.4-12. Compared to Baseline 1, regionwide local personal income generated by sport and commercial fishing activity is substantially lower for Baseline 2, with decreases of $16.2 million in Washington counties, $16.5 million in Oregon counties, and approximately $795,000 in Idaho counties.

Net income (profits) to businesses that are directly affected by sport fishing for salmon and steelhead along the Columbia River is also shown in Table 4.4-7 for Baseline 1 and in Table 4.4-8 for Baseline 2. Under Alternative 1 these businesses would receive an estimated $10.3 million in profits annually. Angler spending on salmon and steelhead fishing for Baseline 1 would generate approximately $5.2 million, $4.7 million, and $400,000 in net income for Washington, Oregon, and Idaho businesses, respectively.

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option A

The personal income effects on the local economy generated by sport fishing for salmon and steelhead and by commercial fishing for salmon under Alternative 2, Option A, are shown in Table 4.4-11 for Baseline 1. In Washington Alternative 2, Option A, would result in an annual increase of approximately $7.0 million in local personal income (a 23 percent increase) from Alternative 1. Counties that would be most affected include Cowlitz (increase of $1.8 million), Pacific (increase of $1.4 million), and Lewis (increase of $1.2 million). In Oregon, local personal income would increase by approximately $4.5 million (an increase of 16 percent). Counties that would be most affected include Clatsop (increase of $595,000) and the three-county area of Hood River/Wasco/Sherman (increase of $582,000) (unspecified counties also would experience large gains). In Idaho local personal income is predicted to increase by approximately 14 percent in all affected counties.

For Baseline 2, local personal income generated by commercial salmon fishers under Alternative 2, Option A, are shown in Table 4.4-12. In Washington Alternative 2, Option A, would result in an annual increase in local personal income of approximately $8.5 million (a 59 percent increase) compared to Alternative 1. Counties that would be most affected include Cowlitz (increase of $2.0 million) and the four-county area consisting of Benton/Yakama/Franklin/Chelan (increase of $1.9 million). In Oregon local personal income would increase by approximately $5.5 million (a 50 percent increase). Counties that would be most affected include Clackamas (increase of $1.8 million) and the three-county area of Hood River/Wasco/Sherman (increase of $1.5 million). In Idaho local personal income generated by sport fishing for salmon in the Columbia River is predicted to increase by approximately 65 percent in all affected counties.

Net income (profits) to businesses that are directly affected by sport fishing for salmon and steelhead is shown in Table 4.4-7 for Baseline 1 and Table 4.4-8 for Baseline 2. For Baseline 1, these businesses would receive an increase of approximately $2.1 million in net income, an increase of 20 percent compared to Alternative 1. Increased angler spending on salmon and steelhead fishing would result in net income increases of approximately

Table 4.4-11. Personal income generated in the local economy in the Columbia River basin under Alternatives 1 and 2 for Baseline 1.

	Alternative 1			Alternative 2, Option A					Alternative 2, Option B				
						Total PI Generated in the Local Economy[1/]					Total PI Generated in the Local Economy[1/]		
State/County	PI Generated by Sport Fishing	PI Generated by Commercial Fishing	Total PI Generated in the Local Economy	PI Generated by Sport Fishing	PI Generated by Commercial Fishing	Value	Change	% Change	PI Generated by Sport Fishing	PI Generated by Commercial Fishing	Value	Change	% Change
Washington													
Pacific	$3,349,100	$810,528	$4,159,628	$4,817,070	$764,674	$5,581,744	$1,422,116	34	$2,932,810	$624,844	$3,557,654	($601,974)	14
Wahkiakum	$992,210	$108,070	$1,100,280	$1,245,740	$101,957	$1,347,697	$247,417	22	$917,090	$83,313	$1,000,403	($99,877)	9
Cowlitz	$6,801,490	$108,070	$6,909,560	$8,626,280	$101,957	$8,728,237	$1,818,677	26	$6,241,220	$83,313	$6,324,533	($585,027)	8
Clark	$1,668,290	$54,035	$1,722,325	$1,668,290	$50,978	$1,719,268	-$3,057	0	$1,668,290	$41,656	$1,709,946	($12,379)	1
Lewis	$5,774,850	$0	$5,774,850	$6,961,120	$0	$6,961,120	$1,186,270	21	$5,411,770	$0	$5,411,770	($363,080)	6
Skamania	$779,370	$0	$779,370	$779,370	$0	$779,370	$0	0	$779,370	$0	$779,370	$0	0
Klickitat	$4,062,740	$0	$4,062,740	$5,026,780	$0	$5,026,780	$964,040	24	$3,878,070	$0	$3,878,070	($184,670)	5
Benton/Yakima/Franklin/Chelan	$5,418,030	$0	$5,418,030	$6,416,500	$0	$6,416,500	$998,470	18	$5,280,310	$0	$5,280,310	($137,720)	3
Unspecified	$669,820	$0	$669,820	$992,210	$0	$992,210	$322,390	48	$579,050	$0	$579,050	($90,770)	14
TOTAL	**$29,515,900**	**$1,080,703**	**$30,596,603**	**$36,533,360**	**$1,019,566**	**$37,552,926**	**$6,956,323**	**23**	**$27,687,980**	**$833,126**	**$28,521,106**	**($2,075,497)**	**7**
Oregon													
Clatsop	$3,414,830	$810,528	$4,225,358	$4,056,480	$764,674	$4,821,154	$595,796	14	$2,992,280	$624,844	$3,617,124	($608,234)	14
Columbia	$1,521,180	$216,141	$1,737,321	$1,596,300	$203,913	$1,800,213	$62,892	4	$1,336,510	$166,625	$1,503,135	($234,186)	13
Multnomah	$2,403,840	$54,035	$2,457,875	$2,507,130	$50,978	$2,558,108	$100,233	4	$2,147,180	$41,656	$2,188,836	($269,039)	11
Clackamas	$9,249,150	$0	$9,249,150	$9,756,210	$0	$9,756,210	$507,060	5	$7,997,150	$0	$7,997,150	($1,252,000)	14
Linn	$582,180	$0	$582,180	$582,180	$0	$582,180	$0	0	$582,180	$0	$582,180	$0	0
Hood River/Wasco/Sherman	$5,208,320	$0	$5,208,320	$5,790,500	$0	$5,790,500	$582,180	11	$5,139,460	$0	$5,139,460	($68,860)	1
Unspecified	$4,018,920	$0	$4,018,920	$6,641,860	$0	$6,641,860	$2,622,940	65	$3,699,660	$0	$3,699,660	($319,260)	8
TOTAL	**$26,398,420**	**$1,080,704**	**$27,479,124**	**$30,930,660**	**$1,019,565**	**$31,950,225**	**$4,471,101**	**16**	**$23,894,420**	**$833,125**	**$24,727,545**	**($2,751,579)**	**10**
Idaho													
Idaho	$1,001,600	$0	$1,001,600	$1,142,450	$0	$1,142,450	$140,850	14	$1,001,600	$0	$1,001,600	$0	0
Nez Perce	$579,050	$0	$579,050	$660,430	$0	$660,430	$81,380	14	$579,050	$0	$579,050	$0	0
Valley	$225,360	$0	$225,360	$256,660	$0	$256,660	$31,300	14	$225,360	$0	$225,360	$0	0
Lemhi/Custer/Clearwater	$450,720	$0	$450,720	$513,320	$0	$513,320	$62,600	14	$450,720	$0	$450,720	$0	0
TOTAL	**$2,256,730**	**$0**	**$2,256,730**	**$2,572,860**	**$0**	**$2,572,860**	**$316,130**	**14**	**$2,256,730**	**$0**	**$2,256,730**	**$0**	**0**
REGION TOTAL	**$58,171,050**	**$2,161,407**	**$60,332,457**	**$70,036,880**	**$2,039,131**	**$72,076,011**	**$11,743,554**	**19**	**$53,839,130**	**$1,666,251**	**$55,505,381**	**($4,827,076)**	**8**

Notes:
1/ Change and % change for angler benefits and net income to businesses are in relation to Alternative 1—No Action.
The zeroes shown for personal income are intended to reflect minor contributions to personal income, not necessarily zero contribution.
Local personal income effects for sport fishing for salmon and steelhead were estimated based on information from the Oregon Angler Survey and Economic Study (The Research Group 1991).
Local personal income effects for commercial fishing for salmon were estimated based on local income factors for the Columbia River used by the Council (Seger, personal communication).
All monetary values are in constant 1996 dollars.
PI = personal income
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

Table 4.4-12. Personal income generated in the local economy in the Columbia River basin under Alternatives 1 and 2 for Baseline 2.

State/County	Alternative 1			Alternative 2, Option A					Alternative 2, Option B				
	PI Generated by Sport Fishing	PI Generated by Commercial Fishing	Total PI Generated in the Local Economy	PI Generated by Sport Fishing	PI Generated by Commercial Fishing	Total PI Generated in the Local Economy[1/]			PI Generated by Sport Fishing	PI Generated by Commercial Fishing	Total PI Generated in the Local Economy[1/]		
						Value	Change	% Change			Value	Change	% Change
Washington													
Pacific	$939,000	$810,528	$1,749,528	$1,965,640	$764,674	$2,730,314	$980,786	56	$848,230	$624,844	$1,473,074	($276,454)	16
Wahkiakum	$435,070	$108,070	$543,140	$682,340	$101,957	$784,297	$241,157	44	$422,550	$83,313	$505,863	($37,277)	7
Cowlitz	$3,155,040	$108,070	$3,263,110	$5,151,980	$101,957	$5,253,937	$1,990,827	61	$3,064,270	$83,313	$3,147,583	($115,527)	4
Clark	$848,230	$54,035	$902,265	$848,230	$50,978	$899,208	($3,057)	0	$848,230	$41,656	$889,886	($12,379)	1
Lewis	$2,729,360	$0	$2,729,360	$4,015,790	$0	$4,015,790	$1,286,430	47	$2,669,890	$0	$2,669,890	($59,470)	2
Skamania	$397,510	$0	$397,510	$397,510	$0	$397,510	$0	0	$397,510	$0	$397,510	$0	0
Klickitat	$1,934,340	$0	$1,934,340	$3,565,070	$0	$3,565,070	$1,630,730	84	$1,906,170	$0	$1,906,170	($28,170)	1
Benton/Yakima/Franklin/Chelan	$2,626,070	$0	$2,626,070	$4,566,670	$0	$4,566,670	$1,940,600	74	$2,604,160	$0	$2,604,160	($21,910)	1
Unspecified	$294,220	$0	$294,220	$694,860	$0	$694,860	$400,640	136	$278,570	$0	$278,570	($15,650)	5
TOTAL	**$13,358,840**	**$1,080,703**	**$14,439,543**	**$21,888,090**	**$1,019,566**	**$22,907,656**	**$8,468,113**	**59**	**$13,039,580**	**$833,126**	**$13,872,706**	**($566,837)**	**4**
Oregon													
Clatsop	$998,470	$810,528	$1,808,998	$1,655,770	$764,674	$2,420,444	$611,446	34	$898,310	$624,844	$1,523,154	($285,844)	16
Columbia	$532,100	$216,141	$748,241	$795,020	$203,913	$998,933	$250,692	34	$488,280	$166,625	$654,905	($93,336)	12
Multnomah	$892,050	$54,035	$946,085	$1,255,130	$50,978	$1,306,108	$360,023	38	$832,580	$41,656	$874,236	($71,849)	8
Clackamas	$3,076,790	$0	$3,076,790	$4,857,760	$0	$4,857,760	$1,780,970	58	$2,782,570	$0	$2,782,570	($294,220)	10
Linn	$297,350	$0	$297,350	$297,350	$0	$297,350	$0	0	$297,350	$0	$297,350	$0	0
Hood River/Wasco/Sherman	$2,497,740	$0	$2,497,740	$4,031,440	$0	$4,031,440	$1,533,700	61	$2,482,090	$0	$2,482,090	($15,650)	1
Unspecified	$1,555,610	$0	$1,555,610	$2,478,960	$0	$2,478,960	$923,350	59	$1,480,490	$0	$1,480,490	($75,120)	5
TOTAL	**$9,850,110**	**$1,080,704**	**$10,930,814**	**$15,371,430**	**$1,019,565**	**$16,390,995**	**$5,460,181**	**50**	**$9,261,670**	**$833,125**	**$10,094,795**	**($836,019)**	**8**
Idaho													
Idaho	$647,910	$0	$647,910	$1,067,330	$0	$1,067,330	$419,420	65	$647,910	$0	$647,910	$0	0
Nez Perce	$375,600	$0	$375,600	$616,610	$0	$616,610	$241,010	64	$375,600	$0	$375,600	$0	0
Valley	$147,110	$0	$147,110	$241,010	$0	$241,010	$93,900	64	$147,110	$0	$147,110	$0	0
Lemhi/Custer/Clearwater	$291,090	$0	$291,090	$482,020	$0	$482,020	$190,930	66	$291,090	$0	$291,090	$0	0
TOTAL	**$1,461,710**	**$0**	**$1,461,710**	**$2,406,970**	**$0**	**$2,406,970**	**$945,260**	**65**	**$1,461,710**	**$0**	**$1,461,710**	**$0**	**0**
REGION TOTAL	**$24,670,660**	**$2,161,407**	**$26,832,067**	$39,666,490	$2,039,131	$41,705,621	$14,873,554	55	$23,762,960	$1,666,251	$25,429,211	($1,402,856)	5

Notes:
1/ Change and % change for angler benefits and net income to businesses are in relation to Alternative 1—No Action.
The zeroes shown for personal income are intended to reflect minor contributions to personal income, not necessarily zero contribution.
Local personal income effects for sport fishing for salmon and steelhead were estimated based on information from the Oregon Angler Survey and Economic Study (The Research Group 1991).
Local personal income effects for commercial fishing for salmon were estimated based on local income factors for the Columbia River used by the (Seger personal communication).
All monetary values are in constant 1996 dollars.
PI = personal income
Under Alternative 3, take of listed fish would be prohibited, and fisheries would be closed. All the related income would, therefore, be lost.

$1.2 million for Washington businesses, $804,000 for Oregon businesses, and $56,100 for sport fishing-related businesses in Idaho for Baseline 1.

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option B

The personal income effects on the local economy generated by sport fishing for salmon and steelhead and commercial fishing for salmon under Alternative 2, Option B, are shown in Table 4.4-11 for Baseline 1. In Washington Alternative 2, Option B, would result in an annual loss of $248,000 in local personal income, representing a 1 percent decrease compared to Alternative 1. Counties that would be most affected include Pacific (loss of $602,000), Cowlitz (loss of $585,000) and Lewis (loss of $363,000). Personal income would increase by $1.7 million in unspecified Washington counties, indicating that income reductions predicted for some counties would likely be less than those shown in Table 4.4-11. In Oregon, local personal income would decrease by approximately $247,000 (a reduction of 10 percent). Counties that would be most affected include Clackamas (loss of $1.3 million) and Clatsop (loss of $608,200). Personal income would increase by $2.2 million in unspecified Oregon counties, indicating that income reductions predicted for some counties would likely be less than those shown in Table 4.4-11. In Idaho, personal income in the local economy would not change under Alternative 2, Option B, compared to Alternative 1.

For Baseline 2, local personal income generated by commercial salmon fishers under Alternative 2, Option B, are shown in Table 4.4-12. In Washington Alternative 2, Option B, would result in an annual loss of approximately $248,000 in local personal income (a 2 percent decrease). Counties that would be most affected include Pacific (loss of $276,500), Cowlitz (loss of $115,500), and Lewis (loss of $59,500). Personal income would increase by $304,000 in unspecified Washington counties, indicating that income reductions predicted for some counties would likely be less than those shown in Table 4.4-12. In Oregon local personal income would decrease by approximately $247,000 (a reduction of 2 percent). Counties that would be most affected include Clackamas (loss of $294,200) and Clatsop (loss of $285,800). Personal income would increase by $513,000 in unspecified Oregon counties, indicating that income reductions predicted for some counties would likely be less than those shown in Table 4.4-12. In Idaho personal income in the local economy would not change under Alternative 2, Option B, compared to Alternative 1.

Net income (profits) to businesses that are directly affected by sport fishing for salmon and steelhead is shown in Table 4.4-7 for Baseline 1 and in Table 4.4-8 for Baseline 2. For Baseline 1 these businesses would receive approximately $10.3 million in net income under Alternative 2, Option B, similar to Alternative 1. Regionwide, net income is not expected to change significantly under Alternative 2, Option B, in Washington, Oregon, and Idaho compared to Alternative 1, although inter-county shifts in net income may occur in Washington and Oregon (Table 4.4-7).

Alternative 3—No Incidental Take

Under Alternative 3, there would be no sport fishing for salmon and steelhead or commercial drift gillnet fishing for salmon in the Lower Columbia River. The effect of this alternative would be to forego the regional economic effects, represented by personal income effects, of these activities on the local economy that are generated under Alternative 1, which are shown in Table 4.4-11 for Baseline 1.

Under Alternative 3, personal income generated by sport fishing for salmon and steelhead and commercial drift gillnet fishing for salmon in local economies throughout the region would be reduced by up to $60.3 million. The actual amount that would be lost depends on the amount of fishing for other species that is substituted for salmon and steelhead. In addition, angler spending in the local economy on substitute goods and services would reduce the negative effects on personal income generation. Assuming that no substitution of spending in the local economy occurs, local economies in Washington, Oregon, and Idaho would lose approximately $30.6 million, $27.5 million, and $2.3 million in personal income, respectively (Alternative 1, Table 4.4-11). Personal income effects would be greatest in Clackamas County, Oregon ($9.2 million), Cowlitz County, Washington ($6.9 million), and the four-county area of Benton/Yakima/Franklin/Chelan, Washington ($5.4 million).

For Baseline 2, personal income generated by sport and commercial salmon fishing in local economies throughout the region would be reduced by up to $26.8 million (Table 4.4-12). As indicated above, the actual amount that would be lost to local economies depends on the level of substitute spending in the local economy. Assuming that no substitution spending occurs, local economies in Washington, Oregon, and Idaho would lose approximately, $14.4 million, $10.9 million, and $291,000 in annual personal income, respectively. Personal income effects would be greatest in Cowlitz County, Washington ($3.3 million), Clackamas County, Oregon ($3.1 million), and Lewis County, Washington ($2.7 million).

Under Alternative 3, net income to businesses that rely on spending by salmon and steelhead anglers would also be reduced. The amount that would be lost depends on the amount of fishing for other species that is substituted for salmon and steelhead; in addition, angler spending in the local economy on substitute goods and services would reduce the negative effects on net income. Assuming that no substitution of spending in the local economy occurs, sport fishing-related businesses in Washington, Oregon, and Idaho would forego approximately $5.2 million, $4.7 million, and $400,000, respectively, for Baseline 1. For Baseline 2, potential reductions in net income to businesses that rely on spending by salmon and steelhead anglers include approximately $2.4 million, $1.7 million, and $259,000 to sport fishing-related businesses in Washington, Oregon, and Idaho, respectively. The reduction in net income to sport fishing-related businesses would be expected to be less because some amount of target species substitution seems likely.

4.4.2.5 Social (Community) Effects

Non-Tribal Commercial Fishing Community

Alternative 1—No Action

There were 689 non-Tribal commercial fishing vessels licensed to fish in the Columbia River in 1997, some of which fish for sturgeon and shad when market conditions permit and some of which are licensed to fish in other areas, such as Grays Harbor, Willapa Bay, or Puget Sound. As noted above, the net income of salmon fisheries for non-Tribal commercial fishermen in the Columbia River would be $700,000 for Baseline 1 and less than $100,000 for Baseline 2 under Alternative 1. Assuming that all vessels participate in the fishery, this is slightly more than $1,000 in net income per vessel for Baseline 1 and slightly less than $122 in net income for Baseline 2. As shown in Tables 4.4-9 and 4.4-10, counties with relatively high levels of estimated net income from non-Tribal commercial fishing include Pacific County, Washington ($31,500 to $264,600); Clatsop County, Oregon ($31,500 to $264,600), and Columbia County, Oregon ($8,400 to $70,500).

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option A

Alternative 2, Option A, would produce small changes in the amount of net income received by commercial fishing communities compared to Alternative 1. As Tables 4.4-9 and 4.4-10 show, these changes would be smaller than under Alternative 2, Option B. Under Alternative 2, Option A, net incomes for commercial fishers in the Columbia River basin would decline by 8 to 19 percent. In monetary terms, these reductions would be small, ranging from $16,300 for Baseline 2 to $53,300 for Baseline 1. The largest reductions would occur in communities in Pacific and Clatsop counties, where net income would decrease by approximately $20,000 in each county.

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option B

Alternative 2, Option B, would produce small changes in the amount of net income received by commercial fishing communities compared to Alternative 1. As shown in Tables 4.4-9 and 4.4-10, net incomes for commercial fishers in the Columbia River would decline by 19 to 24 percent for Baselines 2 and 1, respectively. In monetary terms, however, these regionwide reductions would be small, ranging from $16,300 for Baseline 2 to $167,600 for Baseline 1. The largest reductions would occur in communities in Pacific County, Washington, and Clatsop County, Oregon, where net income would decrease by an estimated $62,800 for Baseline 1.

Alternative 3—No Incidental Take

As noted previously, the net income of salmon fisheries for non-Tribal commercial fishermen in the Columbia River basin under Alternative 1 would be $700,000 for Baseline 1 and less than $100,000 for Baseline 2 (Tables 4.4-9 and 4.4-10). Under Alternative 3, this net income would be lost to non-Tribal commercial fishing communities. In monetary terms, effects would be greatest on commercial fishing communities in Pacific County, Washington, and Clatsop County, Oregon. Net income would decrease by an estimated $31,500 to $264,600 in each county but it is unlikely these reductions would have substantial adverse effects on communities, although commercial salmon fishers and specific businesses that provide goods and services to these fishers would be substantially affected.

Recreational Fishing Community

Alternative 1—No Action

Because the Columbia River basin comprises such a large area with numerous anadromous streams having runs of fish returning throughout the year, it represents an exceptionally large and important recreational fishing resource for the citizens of Washington, Idaho, Oregon, and other areas. The nearly 788,000 annual angler days (Baseline 2) predicted for salmon and steelhead anglers for the Columbia River and its tributaries (Table 4.4-8) is over three times the number of ocean salmon angler trips for the Pacific Coast (Washington, Oregon, and California). Estimated angler days are higher (1.9 million) for Baseline 1 (Table 4.4-7). Angler days are highest for Clackamas County, Oregon, and Cowlitz and Lewis counties, Washington, although a number of counties within the Columbia River basin experience substantial sport fishing activity. Recreational fishing represents both a significant cultural tradition and social benefit for citizens of the region.

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option A

Under Alternative 2, Option A, sport fishing angler days would increase for both Baseline 1 and 2 relative to status quo levels of angler effort. As Tables 4.4-7 and 4.4-8 show, angler days are estimated to increase by 20 and 61 percent for Baselines 1 and 2, respectively. The increased sport fishing activity would have beneficial effects on recreational fishing communities by increasing sport fishing-related expenditures in these communities and by providing enhanced angling opportunities to residents. All counties in the region would benefit from increased angler activity under Alternative 2, Option A. The percentage increases in angler activity would be greatest for communities in Pacific (44 to 109 percent increase) and Klickitat (24 to 84 percent) counties, Washington.

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option B

Because steelhead and trout anglers, and in some cases salmon anglers, are required to release one or another species or to release wild fish depending on the fishery, it is not expected that a mark-selective fishery requirement for salmon (in addition to the one already in place for steelhead) under Alternative 2, Option B, would have any substantial negative effect on participation in the fishery. No such effect has been documented for steelhead mark-selective fishery regulations in the decade or more since their inception. Relative to Alternative 1, sport fishing angler days would decrease slightly under Alternative 2, Option B, for Baselines 1 and 2 (Tables 4.4-7 and 4.4-8).

Alternative 3—No Incidental Take

Because the Columbia River basin consists of a large area, with numerous anadromous streams having runs of fish returning throughout the year, it represents an exceptionally large and important recreational fishing resource for the citizens of Washington, Idaho, Oregon, and other areas. Recreational fishing represents both a significant cultural tradition and social benefit for citizens of the region. Implementation of Alternative 3 would result in a substantial loss of fishing opportunity for Washington, Oregon and Idaho anglers, including the loss of all salmon-related angling effort, which ranges from an estimated 788,000 days under Alternative 1 for Baseline 2 to 1.9 million angler days for Baseline 1. The loss of this activity would substantially reduce angler-related expenditures within the region. As shown in Tables 4.4-7 and 4.4-8, net income to sport fishing-related businesses would decrease by $4.4 to $10.3 million. Sport fishing opportunities for resident anglers would also decline. Reductions in business income and angler opportunities would be greatest in recreational fishing communities in Clackamas County, Oregon, and Cowlitz County, Washington, although all Columbia River basin counties in Washington, Oregon, and Idaho would be substantially affected (Tables 4.4-7 and 4.4-8).

Local Communities and Counties

Alternative 1—No Action

Total personal income for the counties in the Columbia River basin was $26.3 billion in 1994 (Bureau of Census). The $60.3 million of personal income generated in local economies from sport and commercial fishing for Baseline 1 and the $26.8 million generated for Baseline 2 represent 0.23 and 0.10 percent, respectively, of total personal income for counties in this region (Tables 4.4-11 and 4.4-12). The proportion of total personal income related to salmon and steelhead angling exceeded 1 percent in three Washington counties: Wahkiakum (1.7 percent), Klickitat (1.3 percent), and Pacific (1.2 percent).

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option A

Personal income generated by sport and commercial fishing for salmon represents a small percentage of total personal income in all Columbia River basin counties, except Wahkiakum, Klickitat, and Pacific in Washington State. As a result, Alternative 2, Option A, would have little effect on the regional economies of counties within the Columbia River basin, although these changes would be beneficial in virtually every county within the region. As shown in Tables 4.4-11 and 4.4-12, regionwide increases in personal income from salmon fishing under this alternative would range from 19 to 55 percent compared to Alternative 1, although increases could be as high as 84 percent in Klickitat County for Baseline 2.

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option B

As discussed previously, personal income generated by sport and commercial fishing for salmon represents a small percentage of total personal income; thus, Alternative 2, Option B, would have little effect on the regional economies of counties within the Columbia River basin. As shown by Tables 4.4-11 and 4.4-12, regionwide reductions in personal income from salmon fishing would range from 1 to 2 percent compared to personal income levels under Alternative 1; reductions could be as high as 16 percent in Pacific County, Washington, and Clatsop County, Oregon, for Baseline 2. There would be no change in personal income generated by sport and commercial fishing for salmon in Idaho.

Alternative 3—No Incidental Take

Implementation of Alternative 3 would result in the loss of all personal income generated by sport and commercial salmon fishing in the Columbia River basin. As shown in Tables 4.4-11 and 4.4-12, regionwide personal income losses would total more than $60.3 million for Baseline 1 and $26.8 million for Baseline 2. Total personal income for the counties in the Columbia River basin was $26.3 billion in 1994 (Bureau of Census), indicating that the potential loss in personal income for Baselines 1 and 2 would represent 0.23 and 0.10 percent, respectively, of total personal income for counties in this region. As a result, implementation of Alternative 3 would not have a substantial effect on the regional economy. Some communities heavily dependent upon salmon sport and commercial fishing, however, could be substantially affected, including communities where personal income related to salmon and steelhead angling currently exceeds 1 percent (Wahkiakum [1.7 percent], Klickitat [1.3 percent], and Pacific [1.2 percent], counties, Washington).

Columbia River Tribal Communities

Alternative 1—No Action

As comanagers of Columbia River basin fisheries the Tribes set regulations for gear types and fisheries in cooperation with the states; their compliance with NMFS recommendations for the conduct of the fisheries is voluntary. As such, the economic and social effects of salmon harvests under Alternative 1 are not reflected in Tables 4.4-7 through 4.4-12. Salmon fishing, however, is an important component of the socioeconomic structures of Columbia River basin Tribal communities.

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option A

The main effect of Alternative 2, Option B, would be a change in current fishing methods with possible changes in efficiency, depending on the gear type used in place of gillnets. If tangle nets are used to replace gillnets, it is likely that harvest efficiency would fall; however, traps, weirs, or beach seines would likely be more efficient where they could be used. It is impossible to predict the willingness of individual Tribes to change gear types and methods. While it might be argued that abandoning gillnets in favor of other gear types requires a marked change from cultural tradition, it is evident that Tribal fishers have continually innovated in developing gear and methods and/or adopting methods from other cultures, and were the original users of some of the selective-fishing gear types. In British Columbia a large scale program to develop live capture, selective-fishing gear and methods for freshwater salmon fisheries has begun and most innovations are being undertaken by First Nations Tribes. The Puyallup Tribe in Puget Sound is currently participating in a study of tangle net efficiency.

Another cultural effect of the mark-selective fishery approach is the prohibition against keeping wild salmon, which for Tribes have significant cultural/religious significance. Considerable time was devoted to interviewing Tribes for this FPEIS about the issue of releasing wild fish, although not all Tribes responded. A representative of the Yakama Tribe noted that their Tribe places the greatest cultural importance on harvesting wild salmon for ceremonial uses, but the need to harvest wild salmon and steelhead varies by Tribal member and the practice of releasing wild fish caught in commercial or ceremonial and subsistence fisheries varies by individual. Tribal members are trying to avoid harvesting wild steelhead (Parker 1999). With reduced salmonid stocks Warm Springs Tribal members consider the harvesting of wild salmon, a preference for their Tribe, a luxury. Wild steelhead harvested during subsistence fishing on the Deschutes River are released (Fagen 1999). Umatilla Tribal commercial fishermen usually keep both wild and hatchery fish, but in ceremonial and subsistence fisheries wild steelhead are typically released on a voluntary basis, mostly by Tribal members using hook-and-line (James 1999).

Alternative 2—Live Capture, Selective, and Terminal Fisheries, Option B

The effects of Alternative 2, Option B, on Tribal communities would be similar to those described for Alternative 2, Option A.

Alternative 3—No Incidental Take

As comanagers of Columbia River fisheries, the Tribes set regulations for gear types and fisheries in cooperation with the states; their compliance with NMFS recommendations for conduct of the fisheries is voluntary. As such, the Tribes would likely avoid the adverse effects of Alternative 3 by continuing their current fishing practices. It is impossible to predict the willingness of individual Tribes to comply with harvest restrictions imposed under Alternative 3. Should the Tribes comply with these restrictions, they would forego their current harvests of salmon within the Columbia River basin, which would result in substantial economic, social, and cultural effects on the Tribes. In addition to the loss of subsistence harvests, compliance with Alternative 3 would result in the Tribes foregoing their ability to harvest wild salmon for ceremonial uses, an activity of great cultural importance for some Tribes.

4.4.3 Comparison of Alternatives

Alternative 2 would likely have significant economic, cultural, and social effects. Depending on the specifics of how selective fisheries are implemented, effects may include:

- Gear types and fishing technique used by commercial Tribal and non-Tribal fishermen and some Tribal ceremonial and subsistence fishermen would change, necessitating a transition period to determine which gear types are best suited to particular circumstances.
- Expanded use of terminal fishing areas would be necessary to access some harvestable stocks. Because Tribes' usual and accustomed fishing areas are limited geographically, some Tribes might loose access to stocks returning to terminal areas outside their usual and accustomed fishing areas.
- New fishing methods could increase or decrease effort or numbers of fishermen needed to achieve a harvest similar to that under Alternative 1.
- The assumption that wild salmon and steelhead would have to be released. Some Tribal and sport fishermen especially prize wild salmon and steelhead. Tribal fishermen consider the right to harvest wild salmon and steelhead to be guaranteed by treaty and an essential part of their cultural heritage.
- Salmon and steelhead harvested in some terminal areas, as under Alternative 2, Option A, may command a lower market price than those harvested earlier in their spawning migration. This lower market price may be offset by other terminal fishing areas producing higher quality fish and by overall benefits anticipated from greater consistency and predictability of catch from other areas.

For Baseline 1, a mark-selective fishing alternative that did not allow for additional exploitation of hatchery fish and healthy wild fish to offset releases of non-targeted wild fish would have the greatest effect on Tribal commercial fishermen (44 percent decline), followed by Tribal ceremonial and subsistence fishermen in Zone 6 (43 percent decline in harvests), non-Tribal commercial fishermen (18 percent decline), Tribal ceremonial and subsistence fishermen in tributaries (14 percent decline), and recreational fishermen (7 percent decline). The percentage of lost harvests for Baseline 2 would have been slightly less than that for Baseline 1, except lost harvests by commercial Tribal fishermen would have increased to 51 percent because of lost opportunity to retain upriver fall chinook.

Selective fishing offers the opportunity to increase fishing effort on surplus hatchery fish in mixed stock areas, while maintaining existing impact rates on non-target stocks. If all surplus hatchery and healthy natural runs could be harvested, the maximum potential harvest would be approximately 12 to 38 percent greater than under Alternative 1 for Baseline 1 and Baseline 2, respectively. The actual harvest during selective fishing operations would be less than this maximum given the assumptions related to abundance for the benefits of selective harvest and may be even greater if survival conditions improve substantially, as they have over the last few years.

Under Alternative 2, Option A, the benefits of selective harvest accrue to the fisheries as opposed to increasing escapement.

Alternative 3 would have substantial adverse economic, social, and cultural effects on Tribal and sport fishermen, and businesses which depend on them. Importantly, Alternative 3 would effect the trust agreements between Indian Nations and the Federal Government. Production hatcheries would likely close to reduce straying to the spawning grounds, and incentives to monitor the population status of wild stocks would likely diminish.

Alternatives 1 and 2 would both have minor effects on habitat and water quality in the Columbia River basin. The primary effect is from small, localized areas of habitat degradation associated with fishing operations from stream banks. These alternatives would also have relatively minor effects on other species.

Mass-marking of chinook and coho salmon will affect current methods for salmon management because mass-marking requires changing methods for gathering and interpreting data from coded-wire-tags, the primary tool used by fishery management agencies for evaluating changes in salmon production, distribution, and exploitation. Revised sampling and modeling techniques would likely be required for chinook before large-scale selective fisheries could be implemented.

4.4.3.1 Issues Related to Alternative Gear and Methods

Although Alternative 2 does not specify a particular type of gear for achieving a lower incidental mortality rate in fisheries, it is anticipated that gear types would be regulated by the various jurisdictions primarily on the basis of their ability to minimize incidental mortality on released fish. Historically, a number of fishing techniques have been used in the Columbia River and elsewhere, which would in all likelihood have lower incidental mortality rates than the gillnets now employed in the majority of commercial and ceremonial and subsistence fisheries (Table 4.4-13). Many of these methods were employed in the 19th and early 20th century or were employed before the development of non-Tribal fisheries; however, the majority were discontinued for a variety of socioeconomic reasons (Chapter 3). British Columbia is currently experimenting with several of these fishing techniques, but the experiments tend to focus on practical considerations of deployment and design rather than on determining incidental mortality rates. It is assumed that a selective fishery regime would comprise a mixture of selective and terminal fishery gear types and methods based on species composition, location, stock status, and environmental conditions. Table 4.4-13 briefly describes some of the alternative fishing methods which could be employed in the Columbia River system and summarizes key technical and socioeconomic considerations for these methods.

4.4.3.2 Other Issues

Harvest enumeration has historically been a main source of information for monitoring abundance, especially in tributaries below Bonneville Dam. Eliminating fisheries would require changes in the way managers monitor salmon and steelhead populations. Curtailment of salmon fishing in the Columbia River basin without concurrent reduction in hatchery production would lead to large numbers of hatchery fish returning to hatcheries and straying to spawning grounds. Stray hatchery salmon may adversely affect natural spawning populations through competition for spawning sites and mates; interbreeding with natural stocks and alteration of the genetic composition of the natural population; and competition between juvenile hatchery, wild, and hybrid salmon and steelhead (Hindar et al. 1991, Grant et al. 1997). Curtailment of all salmon and steelhead fishing would likely be accompanied by reduced hatchery production to reduce or eliminate many of the potential adverse effects of widespread hatchery straying. Fisheries outside the Columbia River targeting these stocks would decline as a result. Many of the hatchery programs are required as mitigation for various hydro-development projects.

Harvest managers attempt to “shape” fisheries to achieve sufficient spawning escapement for future healthy fisheries or to protect a stock from further decline (e.g., Snake River fall chinook). This is accomplished by setting either spawning escapement goals or harvest rate limits, which may vary with run size. Escapement goals or harvest rate limits typically do not distinguish between naturally produced and hatchery fish, but harvest rates for Columbia River stocks have recently been set to provide protection to weak stocks and have been achieved for most Columbia River stocks in recent years. In general, escapement goals are established at levels to adequately seed the spawning and rearing habitats and potentially produce large future harvests, given favorable environmental conditions. Several of these goals were established before construction of dams and other alterations to habitat, thus, some stocks would not achieve the escapement goal even if the fishery did not exist. Escapement goals were rarely achieved for upriver spring chinook, Snake River spring chinook, Snake River summer chinook, wild upriver summer steelhead (A run), wild upriver summer steelhead (B run), or sockeye salmon. Escapement goals were occasionally met for Willamette spring chinook and upper Columbia River summer chinook, and frequently met for Lewis River bright chinook.

The majority of salmon and steelhead fisheries in the Columbia River basin are directed at hatchery stocks, of which most appear to be receiving sufficient returns in order to meet egg take goals.[11] Notable exceptions to this are Snake River spring/summer and Lower Columbia River chinook facilities; however, low returns are related primarily to low adult survival rates, especially in recent years, rather than to harvests.

[11] Egg take goals vary annually depending on program needs.

Table 4.4-13. Comparison of some alternative gears and fishing methods which could be employed in mark-selective fisheries in the Columbia River.

Method	Description, Location, and Timing Factors	Live Release Capability	Technical Considerations	Socioeconomic Considerations
Tangle Nets	Tangle nets consist of lightweight webbing suspended between a float line and a weighted line. Fish are captured when they become entangled in the fine mesh. Because the mesh size is small in relation to the fish size, fish become entangled by their mouth, snouts, or opercula, rather than their gills. Tangle nets need to be fished where there is some current; therefore, they would not be effective in Columbia River impoundments. As yet, they have only been tested as drift nets.	Research is promising but insufficient . Current estimate of catch-and-release mortality is < 10%.	This gear has been used experimentally in chum salmon fisheries in British Columbia. Tangle nets can be deployed from craft and in a manner similar to the traditional gillnets used by commercial fishermen.	Requires a minor but more labor intensive change in fishing style.
Beach Seines	Beach seines are constructed of relatively heavy Mesh attached to a float line and a weighted line. Fish are captured by encircling them with the seine, then drawing up the bottom portion in "pursing" action. Beach seines are so-called because one end is typically affixed to shore while a boat is used to pull the other end, to encircle fish. This method could be Practical in the Columbia River mainstem. Practical in mainstem, perhaps some areas of the Snake River.	Seine mortality rates are not well established, but promising.	Technology is traditional and was used at the turn of the century by Tribal and non-Tribal fishers in numerous locations.	Requires pooling of labor (i.e., larger crews)
Merwin Traps	Merwin traps are rectangular or tubular shaped traps consisting of a (metallic) frame and netting. Fish can swim into but not out of the trap because of their shape. They are anchored in locations along the suspected migratory path of salmon or other fish.	These traps have been used with some success to collect salmon in the Columbia River for research. Catch-and-release mortality is probably low.	Original traps are large, cumbersome to move, and require very substantial anchoring systems.	Requires pooling of labor (i.e., larger crews)
Weirs	A weir is a blockage or partial blockage on a stream which forces migrating fish to swim into a contained holding area where they can be captured by dip nets or other means. Traditionally, weirs were constructed of natural materials such as logs, wooden stakes, stones, or a combination thereof.	Mortality would occur as part of the dip netting and sorting of catch.	May not be an option in mainstem because of navigation considerations and large size needed to be effective. This is a relatively simple, traditional American Indian/Alaska Native technology that is being experimented with by some Canadian First Nations fishers.	Technology is traditional for Tribes.
Traps	Traps work on the same basic design but generally do not block an entire stream and involve more complicated holding system.	Mortality would occur as part of the sorting of catch.	While this was one of the most common ways of harvesting in the Columbia River in the 1800s, changes in shore line habitat, property ownership, navigation requirements, and river flow may make application more limited.	The technology is traditional for Tribal and non-Tribal fisheries but would require a pooling of labor.
Collection at Dams		With properly developed systems fish from wild runs might be segregated with virtually n o handling-related mortality.	Equipment is already in use at some dams to detect CWT fish. Work is being done with image detection systems to identify fin clipped fish.	Could be highly efficient but would require modification of fish ladder system. Basically, all species and runs except lower river returns could be sorted at Bonneville Dam. While highly efficient, this approach has Obvious social/ cultural drawbacks for traditional fishers.
Fish Traps/Wheels (stationary)	Fish wheels consist of a netting chamber, a set of paddle wheels (also of netting) suspended an axel and a basket section.	Mortality would occur as the fish are scooped by the wheel.	Considerable research is underway by British Columbia Tribes for this technology	Technology is traditional for Tribal and non-Tribal fishers. Numerous traps are being used .

4.5 Cumulative Effects

This section describes the cumulative effects of the proposed alternatives in the three management areas with particular reference to effects on listed ESUs. Cumulative effects are the effects on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes those actions. Cumulative effects can result from individually minor, but collectively significant, actions taking place over a period of time.

Many salmon stocks along the West Coast routinely meet management objectives and are considered healthy, but many stocks are also severely depressed, as is indicated by the number of listed salmonid ESUs. Harvest has contributed, in varying degrees, to the decline of many of these depressed runs that now require special consideration and protection; therefore, NMFS' review of annual fishery management plans, with respect to their effect on listed species and other stocks of concern, is necessary and appropriate. It is also true, however, that the declines of these species were rarely, if ever, solely the result of harvest. As a result, recovery can occur only if the combined effects of all actions that adversely affect these stocks are adequately addressed. Harvest, which is the subject of this FPEIS, plays a critical role because it must be constrained sufficiently to provide adequate escapement and the opportunity for species recovery, particularly in the short term. Remedies in other action areas often take time to implement and even longer to take effect in the sense of providing improvements to survival of the species (e.g., a planned dam removal or changes in forest practices will not provide immediate survival benefits but may be critical to long-term recovery).

There will always be uncertainty regarding future conditions. For example, it is difficult to predict what ocean survival conditions will be in the future. It is also difficult to predict the timing and magnitude of survival improvements related to management actions taken to improve habitat conditions; nevertheless, harvest management decisions must be made based on the best available information regarding the species status, short-term forecasts, trends in survival, and a broad perspective regarding changing conditions in other sectors. As a result, harvest decisions must be reevaluated frequently to ensure their consistency with the expectation of long-term recovery.

The alternatives considered in this FPEIS were designed to meet NMFS' jeopardy standards for protecting listed species at the time of their implementation; therefore, the effects of all the alternatives on the recovery of listed ESUs are beneficial relative to harvest management approaches used in past years (i.e., historical or pre-listing management approaches). Because the proposed alternatives result in varying levels of harvest, incidental take, and spawning escapement, their effects on recovery of salmonid ESUs and on the human environment (i.e., through changes in fisheries) also differ.

In an effort to provide a broad perspective regarding cumulative effects, this section discusses the general inventory of actions that are known to adversely affect salmon habitat and lists the factors for decline that were identified for each of the listed species. NMFS also provides examples of current remedial activities designed, generally, to improve the status of the species. This section then considers, more specifically, the effects of the alternative harvest management strategies that are the focus of this FPEIS. For the listed ESUs and other stock groups, NMFS reviews the general level of harvest effects and how they would change under the proposed alternatives. For several of the ESUs or stocks, risk assessments are available that have considered the degree to which harvest management actions can be expected to contribute to recovery. Results of these risk assessments are reviewed, and additional qualitative comments are provided, when possible, in an attempt to provide some perspective on the proposed alternatives, the degree to which harvest can be expected to contribute to recovery, and the degree to which necessary survival improvements will have to come from other sources of human-induced mortality.

4.5.1 Factors for Decline of Salmonid ESUs

Absent anthropogenic effects, survival of salmon populations within and among distinct populations is subject to wide fluctuations depending on various environmental factors. The greatest mortality for salmonids occurs during incubation, but a significant percentage of the surviving population dies while rearing in freshwater or in the ocean. In freshwater, survival can be reduced by physical factors such as high stream flows and scouring of spawning redds (nests), sedimentation of spawning gravels, extreme temperatures, and low stream flows. Biological factors influencing survival include predation, food availability, and competition for space. Marine conditions, apparently influenced by wide-scale, interdecadal variations in oceanic and atmospheric conditions, influence predator abundance and food availability and may determine much of the annual and long-term variability in survival. Biological and physical factors interact synergistically, and the relative importance of individual factors is difficult to quantify. Salmonid behavior and locally adapted traits, such as time of migration, growth rate, and age at maturity, provide mechanisms allowing species to reduce the probability of mortality in specific environments (Taylor 1991). Human-caused factors contributing to the decline and eventual listing of salmonid ESUs are described in the following:

- Factors contributing to the decline of chinook salmon: an addendum to the 1996 West Coast steelhead factors for decline report (NMFS 1998d)
- Appendix A of Draft Amendment 14 to the Pacific Coast Salmon Plan (Council 1999a)
- Status reviews of Pacific salmon and steelhead (Busby et al. 1996, Meyers et al. 1998, Weitkamp et al. 1995).

Actions that affect recovery of salmon and steelhead populations are often characterized by NMFS as belonging to one of the All-H categories: habitat, hydropower, hatcheries, or harvest, which are summarized below. An inventory of actions affecting salmon habitat and the habitat components likely to be altered by these actions is presented in Table 4.5-1. The factors for decline identified for each of the listed chinook ESUs are summarized in Table 4.5-2 to provide an overview of the similarities and the diversity of factors that affect salmonids across the geographic range of West Coast salmon populations; factors affecting other listed species are similar.

As part of the ongoing efforts of many jurisdictions, a variety of actions are underway or are beginning. These actions are intended to mitigate the negative effects of many of the above actions and include modifications to hydropower and irrigation systems, new forestry management practices, and reform of hatchery management practices. Examples of these actions are presented in Table 4.5-3. Because the various action categories affect salmon stocks synergistically, it can be difficult, and, in some cases, misleading to evaluate the importance of one factor on recovery. The relative importance of these categories on

Table 4.5-1. An inventory of actions affecting salmon habitat.

	Actions likely to affect Salmon EFH							
	Compaction of Soil/Creation of Impervious Surfaces	**Discharge of Wastewater, runoff**	**Estuarine Habitat Alteration**	**Introduce/Transfer/Control of exotic Organisms/Plants/Disease**	**Creation of Migration Barriers/Hazards**	**Marine Habitat Alteration**	**Removal of Prey (Direct Removal)**	**Redd Disturbance (Direct)**
	Examples of Activities that May Involve Those Actions							
	Forestry, agriculture, ranching, road building, construction, urbanization	**Industrial/food processing, mining, desalinization, aquaculture, forestry, agriculture, grazing, urbanization, vessel fueling/repair, dredging, oil/mineral development**	**Jetty or dock construction, dredging, soil disposal, waste discharge, vessel operation (shallow water), ballast water disposal, aquaculture, pipeline installation**	**Aquaculture, bilge water discharge, inter-basin water/fish transfer, fish introduction, boating**	**Dam and irrigation facility construction/operation, road building, navigation lock operation, dock installation, stream bed mining, tide gate installation/ maintenance**	**Dredge spoil disposal, mineral, oil level/transport, wastewater discharge, ballast discharge, spill dispersal, incineration**	**Fishing, dredging, water intakes, water diversions**	**Grazing, fishing, dredging, sand and gravel extraction, reservoir excavation for flood control**
Habitat Components								
Stream Water Quality:								
Temperature	X	X			X			
Dissolved Oxygen	X	X		X	X			
Sediment/ Turbidity	X	X	X		X			X
Nutrients	X	X	X	X	X			
Contaminants	X	X	X	X	X			
Habitat Access:								
Physical Barriers					X			
Stream Habitat:								
Substrate	X	X	X		X			X
Large Woody Debris	X	X			X			
Pool Frequency	X	X			X			
Pool Quality	X	X			X			
Off-channel Habitat		X	X		X			
Prey	X	X		X	X		X	X
Predators				X	X		X	
Channel Condition and Dynamics								
Width/Depth Ratio	X	X			X	X		
Streambank/Channel Complexity	X	X			X	X		
Floodplain Connectivity	X	X			X			
Stream Flow/ Hydrology								
Change in Peak/base flows	X	X			X			
Increase in drainage network	X	X			X			
Estuarine Habitat:								
Extent/Condition of Habitat Types					X	X		
Extent/Condition of Eelgrass Beds						X		
Water Quality, Also Disease and Contaminants		X	X	X		X		
Water Quality/Timing of Fresh Water inflow	X				X	X		
Prey			X	X	X	X	X	
Predators			X	X	X	X	X	
Marine Habitat Elements								
Water Quality/Disease Contaminants		X	X	X		X		
Water Quality/Timing-Riverine Plumes	X							
Prey			X			X	X	

Source: Council 1999a.

Table 4.5-2. Factors for decline for listed chinook salmon ESUs.

Name of ESU	Geographic Range of ESU	Factors Affecting ESU	
Puget Sound	Strait of Juan de Fuca east of Elwha River, Puget Sound, and Hood Canal, WA	Habitat blockages Hatchery introgression Urbanization Logging	Hydropower development Harvest Flood control and flow effects
Snake River spring/summer-run	Snake River, WA, upstream from confluence with Columbia River, Snake and Salmon Rivers, ID	Logging Agriculture Hydropower development	
Snake River fall-run	The Columbia River upstream of the Dalles Dam, including the Deschutes, John Day, Umatilla and Walla Rivers; the Snake River from is confluence with the Columbia River, upstream to hells Canyon Dam, the Clearwater River to its confluence with Lobo Creek, ID; to the Lower Salmon River, ID	Logging Hydropower development Hatchery introgression Mining	Agriculture Water diversion/extraction Habitat blockages Harvest
Upper Columbia River spring chinook	Columbia River tributaries of the Rock Island Dam and downstream of Chief Joseph Dam in Washington, excluding the Okanagan River	Habitat degradation Logging Hydropower development Flood control	Agriculture Artificial propagation Water withdrawal, conveyance, and storage Harvest
Lower Columbia River	Mouth of the Columbia River eastward including tributaries downstream of Willamette Falls, OR and west of the Klickitat River, WA	Hatchery introgression Habitat blockages Logging Eruption of Mt. St. Helens	Hydropower development Predation Harvest
Upper Willamette River	Willamette River, OR from Willamette Falls upstream	Habitat blockages Hatchery introgression Urbanization	Logging Hydropower development Harvest
Central Valley spring-run	Sacramento River, CA and San Joaquin River, CA	Water diversion/extraction Mining Agriculture Urbanization	Habitat blockages Harvest Hydropower development Hatchery introgression
Sacramento River winter-run	Sacramento River, CA	Water diversion/extraction Mining Agriculture Urbanization	Habitat blockages Hydropower development Hatchery introgression
California Coastal Chinook	All coastal rivers and streams south of the Klamath River to the Russian River, CA	Habitat degradation Logging Artificial propagation Water withdrawal, conveyance, and storage	Agriculture Mining Hydropower development Flood control Harvest

Table 4.5-3. Potentially beneficial actions related to listed salmonid stocks.

Action	Examples	Description
Improved Juvenile Fish Passage	Columbia Basin	Programs including increased flow during downstream migration periods improved fish screens to improved fingerling survival.
	California-San Joaquin	Improved fish screen devices etc. to improve fingerling survival. Improved fish passage and water quality in estuarine environments (California Bay Delta program)
Improving Estuarine Environment	Duwamish River (Puget Sound) sediment cleanup and habitat improvement	Several projects are in planning or underway to cap contaminated sediments or improve estuarine habitat in Puget Sound.
Dam Removal	Lower Snake River	Four federally-operated dams on the Lower Snake River have been studied for removal to increase survival of Snake River chinook, steelhead and sockeye salmon juveniles during downstream passage.
	Elwha River	Two privately owned dams on the Elwha River (flowing into the Strait of Juan de Fuca) have been tentatively approved for removal. These dams totally block access to a large spawning area in relatively pristine environment. Affected stock is part of Puget Sound ESU.
	Central and Southern Oregon	Numerous dams on Rogue and its tributaries are being studied for removal to improve access to natural spawning areas.
Dam Re-Licensing/ Modification	All areas	Numerous FERC licensed dams will be reviewed over the next several years. It is likely that renewal of licenses will require meeting more stringent ESA take requirements which could require dam modification.
Modifying Forestry Practices	Washington	A forest practices plan has been developed by the Washington Forest Practices Board which would, among other things, provide for broader riparian buffer zones, improved fish passage and other measures to protect salmon habitat.
	Oregon	A forest practices plan is under development in Oregon which would, among other things, provide for broader riparian buffer zones improved fish passage and other measures to protect salmon habitat.
Hatchery Reform	Washington	The Department of the Interior has instigated a comprehensive program to investigate and, where necessary, reform hatchery management practices. A goal of the program is that hatchery programs should support recovery efforts for listed salmonids.
	Washington Oregon	An abundance-based management system for chinook has been implemented.
Fishing Treaties and Harvest Management Plans	New PST Annex 4 provisions	New provisions of Annex 4 stipulates the general goal of managing fisheries based on total mortality; instead of limiting fisheries by harvest, limiting them by harvest and incidental mortality.
	Wild salmonid policies	The states of Alaska, Washington, and Oregon have adopted wild fish management policies which provide a framework for fisheries management to protect wild stocks.
	Revised management programs in the Columbia River	Implementation of an abundance-based management system for winter, spring, and summer season fisheries in the Columbia River.

species survival will vary between the ESUs; however, some pertinent observations and generalizations can be made. They are discussed in the following analysis.

4.5.1.1 Habitat

There is widespread agreement among the scientific community that loss or alteration of riparian habitat is the primary risk factor for salmon populations as a whole. In most western states, approximately 80 to 90 percent of the historic riparian habitat has been eliminated or altered. Wetlands have diminished by one-third in Washington and Oregon and by 91 percent in California. In Washington and Oregon, sedimentation and other factors have reduced some types of preferred rearing habitat by 58 to 80 percent in some areas (NMFS 1998d). In general, habitat destruction and degradation has had a substantial effect on the survival of salmon and steelhead throughout their range.

The quality and quantity of freshwater habitat in much of the Columbia River basin—32 subbasins provide spawning and rearing habitat—have declined dramatically in the last 150 years. Forestry, farming, grazing, road construction, hydrosystem development, mining, and urbanization have radically changed the historical habitat conditions of the Columbia River basin. More than 2,500 streams and river segments and lakes do not meet Federally approved state and Tribal water quality standards and are now listed as water-quality-limited under Section 303(d) of the CWA. Most of the water bodies in Oregon, Washington, and Idaho listed on Section 303(d) do not meet water quality standards for temperature.

Many tributaries have been significantly depleted by water diversions. In 1993, fish and wildlife, Tribal, and conservation group experts estimated that 80 percent of 153 Oregon tributaries had low-flow problems (two-thirds caused in part by irrigation withdrawals). The NWPPC showed similar problems in many Idaho, Oregon, and Washington tributaries. In addition, more than 50 percent of the original marshes and spruce swamps in the estuary have been converted to industrial, transportation, recreational, agricultural, or urban uses.

On a larger landscape scale, human activities have affected the timing and amount of peak water runoff from rain and snowmelt. Forest and range management practices have changed vegetation types and density, which can affect timing and duration of runoff.

Many riparian areas, floodplains, and wetlands that once stored water during periods of high runoff have been developed. Urbanization paves over or compacts soil and increases the amount and pattern of runoff reaching rivers and streams.

As noted in the previous section, there are many ongoing efforts designed to improve habitat conditions and promote the conservation of salmon and steelhead populations. Some of these are listed in Table 4.5.3. There is a more detailed discussion of cumulative effects and related conservation initiatives for the Columbia River basin and Washington and Oregon coastal areas in NMFS' recent biological opinion regarding Columbia River fisheries (NMFS 2001). More generally, state, Tribal, and local government actions will likely take the form of legislation, administrative rules, or policy initiatives. Government and private actions may encompass changes in land and water uses (including ownership and intensity), any of which could impact listed species or habitat.

Government actions are subject to political, legislative, and fiscal uncertainties. These realities, added to the geographic scope of the action area, which encompasses numerous government entities exercising various authorities and the many private landholdings, make any analysis of cumulative effects difficult and speculative. It is, nonetheless, important to consider actions designed to improve habitat conditions as part of the cumulative effects.

4.5.1.2 Hydropower and Irrigation

Water diversions for agriculture, flood control, domestic, and hydropower purposes have greatly reduced or eliminated habitat, especially in the Columbia River and Sacramento-San Joaquin River basins. In the Columbia River basin, dams have eliminated access to approximately 55 percent of the basin area and 31 percent of the river miles historically available to salmon and steelhead (NRC 1996). Storage dams have eliminated spawning and rearing habitat and have altered the natural hydrograph of the Snake and Columbia rivers, decreasing spring and summer flows and increasing fall and winter flows. Run-of-river dams have altered physical and biological characteristics of the river environment and reduced survival of downstream-migrating juvenile salmonids and upstream-migrating adults. Power operations cause flow levels and river elevations to fluctuate, affecting fish movement through reservoirs and riparian ecology, and stranding fish in shallow areas. The eight dams in the migration corridor of the Snake and Columbia rivers alter smolt and adult migrations.

There have been numerous changes in the operation and configuration of the Federal Columbia River Power System (FCRPS) as a result of ESA consultations between the Action Agencies (BPA, the Corps, and BOR) and the services (NMFS and USFWS). In addition to spill, flow, and transportation improvements, the Corps implemented numerous other improvements to project operations and maintenance at all Columbia and Snake river dams. It is possible to quantify the survival benefits accruing from these many actions for each of the listed ESUs. For Snake River spring/summer chinook smolts migrating inriver, the estimated direct survival through the hydrosystem is now between 40 and 60 percent compared with an estimated survival rate during the 1970s of 5 to 40 percent. Snake River steelhead have probably received a similar benefit because their life history and run timing are similar to those of spring/summer chinook (NMFS 2000b).

4.5.1.3 Hatcheries

For more than 100 years, hatcheries in the Pacific Northwest have been used to replace natural production lost as a result of the FCRPS and other development, not to protect and rebuild natural populations. As a result, most salmon populations in this region are primarily hatchery fish. In 1987, for example, 95 percent of the coho, 70 percent of the spring chinook, 80 percent of the summer chinook, 50 percent of the fall chinook, and 70 percent of the steelhead returning to the Columbia River basin originated in hatcheries (CBFWA 1990). Many hatchery stocks can sustain much higher harvest rates than natural stocks because hatchery practices protect fish during the critical egg and fry stages. As a result, more smolts can be produced from a given number of spawners. If hatchery stocks are targeted in mix-stock fisheries, less productive wild stocks may be overharvested. Much has been done to reform hatchery practices in recent years to reduce the adverse effects and these efforts remain ongoing. It is also important to recognize the beneficial aspects of hatcheries that are, in some cases, essential to species preservation and recovery.

While hatcheries have contributed greatly to the overall numbers of salmon, only recently has the effect of hatcheries on native wild populations been demonstrated. In many cases these effects have been substantial. For example, production of hatchery fish, among other factors, has contributed to the 90 percent reduction in wild coho salmon runs in the Lower Columbia River over the past 30 years (Flagg et al. 1995). Hatcheries have traditionally focused on providing fish for harvest, with less attention given to identifying and resolving factors causing declines of native runs. One of the prime recommendations in the National Research Council's (NRC's) study of salmon in the Pacific Northwest is that hatchery use "should occur within the context of fully implemented adaptive-management programs that focus on watershed management, not just on the fish themselves" (NRC 1996).

NMFS has identified four primary categories of risk that hatcheries can pose on wild-run salmon and steelhead: 1) ecological effects, 2) genetic effects, 3) overharvest effects, and 4) masking effects (NMFS 2000c). Ecologically, hatchery fish can increase predation on, displace, and/or compete with wild fish. Genetically, hatchery fish can affect the genetic variability of native fish via interbreeding, either intentionally or accidentally. Interbreeding can also result from the introduction of native stocks from other areas. Theoretically, interbred fish are less adapted to and productive within the unique local habitats where the original native stock evolved.

In many areas, hatchery fish provide increased fishery opportunities. When wild fish mix with hatchery stock, fishing pressure can lead to overharvest of smaller or weaker wild stocks. Furthermore, when migrating adult hatchery and wild fish mix on the spawning grounds, the health of the wild runs and the condition of the habitat's ability to support runs can be overestimated because the hatchery fish mask surveyors' ability to discern actual wild run conditions.

Problems associated with hatchery practices have been apparent for some time, and there are ongoing efforts to reform hatchery practices to address those problems. For example, NMFS determined that there is a need for immediate hatchery reform within the Columbia River basin (Federal Caucus 2000). As a result, federal agencies are working to accelerate funding and implementation of the reform measures from the hatchery biological opinions and related actions that should proceed over the next 1 to 3 years. Such reforms will be pursued in the context of hatchery and genetic management plans (HGMPs). HGMPs are tools for defining goals and objectives of particular hatcheries and the relationship to prioritized basin objectives, including harvest opportunities and wild stock performance. Specifically, each HGMP should ensure that genetic broodstock selected is appropriate, that it minimizes the potential for adverse ecological effects on wild populations, and that it is integrated into basinwide strategies to meet the objectives of all four Hs. The states have adopted similar hatchery reform programs as part of their wild stock recovery efforts. Detrimental effects associated with hatchery programs are being reduced as a result of the ongoing efforts. More hatchery conservation programs that are specifically designed to address critical needs such as the Snake River sockeye captive brood stock program are being developed.

4.5.1.4 Harvest

Fishing (i.e., harvest) reduces the number of adult salmon returning to the spawning grounds and in some cases, harvest practices may alter species size, fecundity, age structure, and migration timing. Harvest may also alter the structure of ecosystems by reducing inputs of nutrients from the carcasses of spawned salmon. Harvest restrictions have been used for decades to achieve spawning escapements; however, inadequate restrictions or other fishery management actions in the past have contributed to declines in natural salmon populations through error, lack of understanding and misguided policy decisions.[12] More recent efforts have focused increasingly on scientific-based management objectives and on managing mixed-stock fisheries to meet the objectives of weak stocks.

In the Columbia River basin, freshwater fisheries declined during the first half of this century, while ocean fisheries grew, particularly after World War II. This trend occurred up and down the West Coast as fisheries with new gear types leapfrogged over the others to gain first access to the migrating salmon runs. Large, mixed-stock fisheries in the ocean gradually supplanted the freshwater fisheries, which were increasingly restricted or eliminated to protect spawning escapements. By 1949, the only freshwater commercial gear types remaining were gill nets, dip nets, and hoop nets (ODFW and WDFW 1998). This leapfrogging by various fisheries and gear types resulted in conflicts about harvest allocation and the displacement of one fishery by another. Ocean trolling peaked in the 1950s; recreational fishing peaked in the 1970s. The ocean harvest has declined since the early 1980s as a result of declining fish populations and increased harvest restrictions (ODFW and WDFW 1998).

The extent to which harvest practices have been factors for listing varies by stock and ESU. For some stocks harvest reductions or moratoria in and of themselves could be sufficient to reverse declining population trends in the short- to medium-term. For others, even complete harvest moratoria cannot achieve this end. Maintaining low harvest effects while improving habitat will improve the chances of recovery, but this benefit may be compromised if the increased escapement includes a large percentage of stray hatchery-reared fish.

The capacity of salmonids to produce more adults than are needed for spawning offers the potential for sustainable harvest of naturally produced (versus hatchery-produced) fish. This potential can be realized only if two basic management requirements are met: 1) enough adults return to spawn and perpetuate the run and 2) the productive capacity of the habitat is maintained. Catches may fluctuate in response to such variables as ocean productivity cycles, periods of drought, and natural disturbance events; however, as long as the two management requirements are met, fishing can be sustained indefinitely. Unfortunately, both prerequisites for sustainable harvest have been violated routinely in the past. The lack of coordinated management across jurisdictions, combined with competitive economic pressures to increase catches or to sustain them in periods of lower production, resulted in harvests that were too high and escapements that were too low. At the same time, habitat has been increasingly degraded, reducing the capacity of the salmon stocks to produce numbers in excess of their spawning escapement requirements.

For years, the response to declining catches was hatchery construction to produce more fish. Because hatcheries require fewer adults to sustain their production, harvest rates in

[12] Common shortcomings have been an incomplete or inaccurate understanding of the relationship between spawners and subsequent returns, failing to recognize or take into account a decline in the underlying productivity of the stock (e.g., from habitat degradation or long-term climatic decline), and implementing harvest rates based on strong stocks (hatchery or wild) to the detriment of less productive stocks.

the fisheries were allowed to remain high, or even increase, further exacerbating the effects of overfishing on wild runs mixed in the same fisheries. More recently, harvest managers have instituted reforms including weak stock, abundance-based, harvest rate, and escapement-goal management.

For most ESUs, there are no quantitative benchmarks to define recovery; however, it is reasonable to expect that future recovery plans will include both numerical escapement goals and remediation of environmental factors as dual de-listing criteria. Quantitative benchmarks notwithstanding, actions related to habitat, hydropower, and hatcheries have been subject to review and consultation since the initial listings. Describing the short-term effects of the proposed alternatives within the context of other factors for decline can provide useful insights about the role harvest management alternatives play in relation to and combination with other recovery actions.

With reference to listed Columbia River chinook stocks, NMFS (2000b) contains the following information:

> . . . harvest reductions offer a plausible way to reduce risk for the few ESUs that presently bear substantial harvest burdens. . . . ESUs that may be particularly likely to benefit from harvest reductions include Lower Columbia chinook, Upper Willamette chinook, and Snake River fall chinook.

For the majority of ESUs, harvest reductions alone are unlikely to adequately mitigate risks, but they are nonetheless an important component of an integrated approach to recovery.

4.5.2 Combined Effects of Alternative Actions in the Three Jurisdictions

This section describes, to the extent possible, the cumulative effects of the harvest management alternatives on listed salmonids and other stocks and their importance relative to and in combination with other human-related factors that affect salmonid populations.

Several ESUs are subject to the gauntlet effect of fisheries that occurs in several areas: fish are removed from the total stock in one fishery, the smaller stock is subject to another fishery, and so on. Snake River fall chinook, for example, are distributed in the ocean from Alaska to central California and are, therefore, vulnerable to the full range of ocean and inriver fisheries. Other ESUs are affected by relatively few fisheries. Lower Columbia River steelhead, for example, are taken primarily in terminal sport fisheries and, to a lesser extent, commercial net fisheries in the Lower Columbia River. The effect of the various alternatives on a particular ESU, therefore, depends on the degree to which they are affected by each fishery. Because there is no single model that accounts for the effects of all fisheries for most stocks, conducting a quantitative analysis on the cumulative effects of the fisheries and the proposed alternatives can be difficult. For Snake River fall chinook, NMFS provides a simplified example of the distribution of harvest mortality among the proposed alternatives, and how escapement estimates would differ assuming that Alternative 1, 2, or 3 was implemented simultaneously in each area. Where possible, discussions of available risk assessments are included to provide insights regarding the degree to which changes in harvest, relative to past practices, can contribute to species recovery.

4.5.2.1 Listed California and Oregon Coho ESUs

Loss of habitat has been identified as the primary factor in stock declines for the central California, southern Oregon/northern California, and Oregon coast (OCN) Natural coho ESUs; hatchery influences and overharvest have also contributed significantly. The southern Oregon/northern California ESU is affected primarily by sport and commercial fisheries off northern California and southern Oregon. The distribution of OCN coho overlaps substantially with that of the southern Oregon/northern California ESU, although OCN coho are caught in fisheries as far north as British Columbia. Exploitation rates on the OCN ESU have declined steadily over the last quarter century, ranging from a high of 90 percent in 1976 to a low of 6 percent in 1998 (Council 2001b [Pre I Report]). Harvest rates for southern Oregon/northern California coho in recent years have been similar to, but generally lower than, those for OCN coho. There are no direct estimates of harvest rates on the central California coho ESU in the Pacific Coast fishery, but they are likely most similar to those of southern Oregon/northern California coho. Management measures for OCN coho under Alternative 1 are those contained in Amendment 13 to the Pacific Coast Salmon Plan, which established a harvest rate schedule that depended on prior escapements and indicators of ocean survival. Alternative 1 has reduced harvest rates on OCN coho (and presumably southern Oregon/northern California and central California coho) by foregoing or severely restricting harvest of all natural origin coho in ocean fisheries, especially south of the Columbia River. Actual harvest rates on OCN coho ranged from 7 to 12 percent since 1994 (Council 2001b). For purposes of this analysis, the harvest rates were presumed to range from 8 to 10 percent under Alternative 1. Under Alternative 2, incidental mortality rates on OCN coho would range from 8 to 10 percent under Option A and from 3 to 4 percent under Option B, depending on the baseline conditions assumed in the analysis (Table 4.3-8).

Because the are no harvest-related effects on these ESUs in the Southeast Alaska and Columbia River fisheries, alternative management actions in those regions would have little or no effect on the listed coho ESUs. There is a small catch of OCN coho in Canadian fisheries; consequently, there would still be a minor harvest effect under Alternative 3. Because there is relatively little effect from tributary fisheries in Oregon (fisheries have been constrained to times and areas where hatchery fish predominate), changes in ocean harvest effects in the Council management area approximate the expected changes in spawning escapement.

The Oregon Department of Fish and Wildlife (ODFW) and NMFS conducted a risk assessment of the status quo management regime (described in Amendment 13 to the Pacific Coast Salmon Plan) for OCN coho (ODFW and NMFS 1998). The risk assessment compared the proposed management to zero harvest using conservative assumptions (those likely to provide higher estimates of risk) and provided estimates of extinction probability, expressed as a proportion, over a 100-year period for coho stocks in 13 basins along the Oregon coast. For 10 of the 13 basins, extinction probabilities were less than 0.05, with most being well below 0.01. Extinction probabilities (with no harvest) were estimated to be 0.05, 0.06, and 0.22 for the remaining three basins, and under Amendment 13 (status quo) management, the probabilities increased to 0.09, 0.12, and 0.32, respectively (refer to risk assessment and associated biological opinion for a detailed discussion [ODFW and NMFS 1998, NMFS 1999b]). These reported values are best considered as relative measures of risk rather than absolute measures of extinction.

In general, the results indicate the following:

- Risk is quite low for most basins.
- Risk exists, even with no harvest.
- Risk increases with harvest, even with a conservative management regime.

After reviewing the available information, NMFS concluded that management of OCN coho under Amendment 13 was consistent with ESA requirements. When Amendment 13 was adopted in 1997, the Council stipulated that the Pacific Coast Salmon Plan should be reviewed and updated periodically. The first review occurred in 2000 (Sharr et al. 2000). Support for the Pacific Coast Salmon Plan was affirmed, but the harvest management matrix was refined and made more conservative when population levels and survival conditions are low.

4.5.2.2 California and Southern Oregon Chinook ESUs

Loss of habitat, hatchery influences, and, in some cases, hydropower interactions are thought to be the primary reasons for decline of these ESUs; however, harvest also played a significant role in the decline of these stocks. Most fishery effects on Sacramento River winter chinook (an ESU in this group of stocks) occur south of the KMZ off central and north-central California. Little is known about distribution of Central Valley spring-run, California Coastal, or southern Oregon/northern California chinook ESUs, although they are generally assumed to reside off southern Oregon and California. None of these ESUs would be affected significantly by actions in the Southeast Alaska or the Columbia River basin fisheries (Myers et al. 1998).

The estimated harvest rate on Sacramento winter run chinook under Alternative 1 ranged from 8 to 18 percent for the two baselines compared to historical harvest rates of approximately 54 percent (Myers et al. 1998). Alternative 2 would reduce the harvest rate to 5 percent or less under either baseline (Table 4.3-7). Under Alternative 3, harvest rates would be reduced to zero.

Management actions have been taken to reduce the harvest of Sacramento winter run chinook in fisheries off the California coast since 1996, and they have been coupled with additional actions to improve habitat conditions inriver (California State Water Contractors 2002). For this ESU, the combined effect of these remedial actions has been to substantially increase escapement in recent years. Although the method for measuring the escapement of winter run chinook is in transition from one that depended on a limited set of dam counts to one that depends on carcass surveys, the more recent information shows that escapements have increased steadily from 664 in 1996 to 6,469 in 2000. The preliminary escapement estimate for 2001 is 10,000 winter run chinook.

There is little direct information on harvest rates for the Central Valley spring-run ESU. The Central Valley fall chinook harvest rate index under Alternative 1 is 73 percent. Because of timing considerations, however, it is likely that the harvest rate on spring-run fish is significantly lower than that of the fall run. Under Alternative 2, harvest rates would range from more than 19 to more than 27 percent under Option A and from 22 to more than 23 percent under Option B, depending on the baseline assumed in the analysis (Table 4.3-7). There was insufficient information available to estimate a change in harvest rate for the Central California and southern Oregon/northern California ESUs. Fisheries in Southeast Alaska and British Columbia are not believed to affect these ESUs; consequently, ocean harvest rates under Alternative 3 would approach zero percent. These stocks would likely benefit from the higher escapements that would result from either Alternative 2 or 3, but the lack of information makes it difficult to be more specific.

4.5.2.3 Columbia River Chinook ESUs

Snake River Spring/Summer and Upper Columbia River Spring-Run ESUs

With historical harvest rates ranging from 6 to 9 percent for these ESUs, fishing is believed to have played a minor role, at least during the last 20 or 30 years, in the decline of Snake River spring/summer and Upper Columbia River spring-run ESUs. Under Alternative 1, harvest rates for Upper Columbia River and Snake River spring stocks were assumed to range between 6 and 7 percent. Under Alternative 1, harvest rates for the summer stocks were presumed to be 2 percent (Tables 4.4.5 and 4.4.6). Under Alternative 2, harvest rates in the Columbia River basin would be reduced to 1 percent or less. Ocean harvest rates in Southeast Alaska, British Columbia, and the Pacific Coast are all believed to be less than 1 percent (Council 1999a, Myers et al. 1998); as a result, there is little added effect from Alternative 2 in these areas. Under Alternative 3, fishery effects would approach zero percent.

The overall rate of survival for these ESUs must increase substantially to provide adequate assurance of future recovery. As indicated above, harvest rates on these ESUs have been held to low levels for many years and are quite low even under Alternative 1. McClure et al. (2000) concluded that reducing harvest to zero would have only a marginal effect on the overall need for survival improvements for these ESUs. Recovery will depend, to some extent, on the continuation of low harvest rates, to some extent, but will primarily result from achieving survival improvements from other sectors that affect these stock's life history.

Lower Columbia River ESU

The Lower Columbia River ESU, as well as the Upper Willamette River and Snake River fall chinook ESUs, are subject to a range of ocean fisheries and both commercial and recreational fisheries within the Columbia River basin. Historic harvest rates on these ESUs were generally higher compared to other ESUs in the Columbia River basin. As a result, McClure et al. (2000) concluded that among all the listed ESUs in the Columbia River basin, these three ESUs would benefit most from harvest reductions, and necessary survival improvements could be met through harvest reductions alone.

The Lower Columbia River ESU consists of both fall and spring-run stocks with varying susceptibility to fisheries (e.g., within a run type, different stocks have different ocean distributions, thus generalizing about total fishery effects is difficult). Recent brood year exploitation rates on fall-run tule type stocks ["Tules" refer to fall chinook stocks that spawn within a few weeks of river return—see glossary for more complete definition.] have been approximately 50 percent lower than in previous years. For example, the total exploitation rate on Washington origin tules averaged 63 percent for broods 1982 to 1989 and 28 percent for broods 1990 to 1995. These fishery reductions occurred in both ocean

(45 percent versus 21 percent) and freshwater fisheries (18 percent versus 6 percent). A similar pattern can be seen for Columbia River tules originating in Oregon. For the same periods, the total AEQ ["AEQ (adult equivalent) is the potential contribution of fish of a given age to the spawning escapement in the absence of fishing—see glossary for a more complete definition.] brood rates decreased from 65 to 40 percent. Ocean rates decreased from an average of 57 to 31 percent, while freshwater fishery effects remained relatively constant at approximately 8 percent.

Fishery effects on the bright component of the ESU have been very similar to those for Washington origin tules (see glossary for a definition of brights). Average AEQ ocean effects on the Lewis River bright stock ranged from 48 percent for brood years 1982 to 1989 to 27 percent for broods 1990 to 1995. Freshwater fishery effects for the same broods averaged 24 and 13 percent, respectively. The observed total exploitation rate for the bright stock for Baselines 1 and 2 were approximately 54 and 31 percent, respectively (Table 4.2-2), reflecting the general decline in rates in more recent years. In general, harvest effects on spring stocks are lower than for all stocks. The PSC chinook model estimates that average AEQ ocean exploitation rates were 28 percent for brood 1982 to 1989 versus 16 percent for broods 1990 to 1995.

Of the various Lower Columbia River stock types, bright stocks have the most northerly distribution and are most affected in Alaskan fisheries. Under Alternative 1, the exploitation rates on Lewis River brights ["Brights refer to fall Chinook stocks that are less mature at freshwater entry than tules—see glossary for a more complete definition.] would range between 8.5 and 9.5 percent, depending on the baseline. Under Alternative 2, exploitation rates would be reduced to 8.3 and 9.3 percent, respectively (Table 4.2-2). Under Alternative 3, exploitation rates would be zero, and the effects would transfer to other fisheries, to escapement, or would be lost to natural mortality, depending on how subsequent fisheries are managed.

Exploitation rates for Lewis River brights under Alternative 1 in Council-managed fisheries were calculated for purposes of this analysis to be between 6 and 7 percent for Baselines 1 and 2, respectively. Under Alternative 2, the incidental mortality rate would range from 2 to 8 percent, depending on the option considered (Table 4.3-7). Because Council-managed fisheries are subject to multiple stock constraints, harvest effects may actually increase for some stocks under Alternative 2, depending on which stocks are limiting in particular years.

Harvest rates in Columbia River fisheries on Lewis River brights ranged from 12 to 38 percent under Alternative 1. Under Alternative 2, which assumes full implementation of selective fisheries, harvest rates would be reduced to 2 to 4 percent depending on the baseline (Tables 4.4-5 and 4.4-6).

The Lewis River bright stock is healthy and has met its escapement goal of 5,700 in all but one of the last 20 or more years; therefore, further harvest restrictions are not needed for conservation reasons. As one of the few healthy stocks in the Lower Columbia River ESU, McClure et al. (2000) concluded that reductions in harvest rates from historic levels for this ESU would contribute significantly to its recovery. This would likely be true especially for Lower Columbia River tule stocks.

All of the Lower Columbia River chinook stocks have been affected substantially by habitat degradation. Spring stocks in particular have been affected by dams that block most of the historic spawning habitat without providing for juvenile or adult passage. The remnants of these stocks are now supported primarily by hatchery programs because there is little opportunity for natural production. Fisheries are managed to ensure that hatchery escapement goals are met, thus maintaining the genetic legacy of the resource, but long-term recovery of natural populations depends, at least initially, on providing access to suitable upstream spawning and rearing habitat.

Upper Willamette River Spring-Run ESU

The Upper Willamette River spring-run chinook are subject to a range of ocean fisheries and to both commercial and recreational fisheries within the Columbia River basin. Historic harvest rates on these ESUs were generally higher compared to other ESUs in the Columbia River basin. As a result, McClure et al. (2000) concluded that among all the listed ESUs in the Columbia River basin, these three ESUs would benefit most from harvest reductions, and necessary survival improvements could be met through harvest reductions alone.

Historically, the overall harvest rate for Upper Willamette spring averaged approximately 65 percent and most of the effects occurred inriver. The ocean fishery effect rate on Willamette spring chinook averaged 22 percent for 1975 to 1983 brood years, 14 percent for 1984 to 1989 brood years, and 9 percent for 1990 to 1993 brood years. Most of the ocean effects occurred in Canadian fisheries and, to a lesser extent, Alaskan fisheries. Upper Willamette spring chinook return early to the Columbia River and are therefore subject to little harvest in Council-managed fisheries. Harvest rates in freshwater fisheries ranged from 30 to 50 percent between 1970 and 1995 (ODFW 2001). The total exploitation rate for Upper Willamette spring chinook for Baselines 1 and 2 averaged 43 and 36 percent, respectively (Table 4.2-2).

Implementing Alternative 2 for ocean fisheries, regardless of the option considered, would have little effect on the overall harvest rates relative to Alternative 1. Alternative 2 in Southeast Alaska provides little change in the mortality rate of chinook stocks taken in the fishery (Table 4.2-2) and would also have little effect if implemented in Council-managed fisheries because of the fisheries' low effect. Implementing Alternative 2 in freshwater fisheries, however, does provide a substantial opportunity for reducing harvest effects; in fact, ODFW has implemented a selective fisheries program that is consistent with Alternative 2. All hatchery fish from the Willamette River are marked and, beginning in 2002, all freshwater fisheries will be managed using selective fishing regulations that require the release of all unmarked, natural-origin fish. ODFW estimated that the average annual harvest rate on stocks returning to the Willamette River will be reduced from historic levels to less than 8 percent (ODFW 2001). The more general analysis used in this FPEIS suggests that harvest rates for freshwater fisheries would be reduced from 43 to 52 percent and from 4 to 5 percent under Alternatives 1 and 2, respectively, depending on the baseline (Tables 4.4-5 and 4.4-6).

In order to analyze the proposed management regime, ODFW (2001) conducted a risk assessment. Results from that assessment indicated that quasi-extinction risk for the Mckenzie River wild population is reduced from 31 percent under the historic fishing regime to less than 0.1 percent under Alternative 2. McClure et al. (2000) concluded that Upper Willamette spring chinook could benefit from significant harvest reductions, but was not specific about how much of a reduction was required. ODFW's proposed management regime and the associated risk assessment provides a specific proposal and analysis that confirms McClure's conclusion. There is an indication that a revised harvest strategy, which is being phased in, and the resulting harvest rate reductions, which have already occurred, in combination with other conservation measures are resulting in positive population growth (e.g., the counts of wild fish at Leaburg Dam have increased steadily from 825 to more than 2,000 from 1994 to 2000 [ODFW 2001]).

Snake River Fall ESU

The Snake River fall chinook ESUs, as well as the Lower Columbia River and Upper Willamette River ESUs, are subject to a range of ocean fisheries and both commercial and recreational fisheries within the Columbia River basin. Historic harvest rates on these ESUs were generally higher compared to other ESUs in the Columbia River basin. The loss of spawning and rearing habitat and the degradation of migration habitat are the primary reasons why this ESU is considered threatened. As a result, McClure et al. (2000) concluded that, among all the listed ESUs in the Columbia River basin, these three ESUs would benefit most from harvest reductions, and necessary survival improvements could be met through harvest reductions alone.

Snake River fall chinook are affected by ocean fisheries from northern California to Southeast Alaska and in the Columbia River. Before listing in 1991, exploitation rates averaged approximately 71 percent for all areas combined; approximately 45 percent of these effects occurred in Canadian fisheries, 6 percent in Alaska, 20 percent in Council-managed fisheries, and 29 percent inriver. The total exploitation rate for Snake River fall chinook during Baselines 1 and 2 were 72 and 45 percent, respectively. In the analysis for this FPEIS NMFS considered what the exploitation rate would have been if the fisheries were managed in past years under Alternatives 1 and 2. Given the alternatives, the exploitation rate estimates for Snake River fall chinook in the Alaskan fisheries ranged between 4.3 and 4.6 percent under Alternative 1 for Baselines 1 and 2, respectively. These exploitation rate estimates would decline to 4.2 and 4.5 percent under Alternative 2 and to zero under Alternative 3 (Table 4.2-2).

The observed exploitation rate on Snake River fall chinook in Council-managed areas ranged from approximately 16 to 22 percent for Baseline 1 and decreased to an average of 6 percent for Baseline 2. In the analysis, NMFS again attempted to estimate what the exploitation rates would have been under Alternatives 1 and 2. Under Alternative 1, NMFS estimated that the exploitation rate would have ranged from 8 to 10 percent; under Alternative 2, the exploitation rate ranged from 3 to 7 percent depending on the baseline and option considered (Table 4.3-7).

The observed harvest rate on Snake River fall chinook for inriver fisheries averaged approximately 45 percent for Baseline 1 and 24 percent for Baseline 2. For purposes of this analysis NMFS again estimated what the harvest rates would have been if fisheries were managed under the proposed alternatives. In some cases, the actual harvest rate was lower than that allowed under the ESA consultation, which defined Alternative 1. These lower observed rates were incorporated into the average for the baselines. Estimated harvest rates under Alternative 1 were 29 and 21 percent for Baselines 1 and 2, respectively; under Alternative 2, which assumed full implementation of selective fisheries, the harvest rates would have been reduced to 2 to 3 percent (Table 4.4-7).

Snake River fall chinook were used in the analysis to provide a simple example of the cumulative effects of implementing the proposed alternatives across each of the management jurisdictions at one time (Table 4.5-4). In this analysis, NMFS provides estimates of the abundance of Snake River fall chinook during the respective baselines and the expected catches in each of the fishery jurisdictions, including British Columbia. Also included are estimates of inter-dam loss representing the number of fish lost during upstream migration. These numbers were then used to estimate the changes in catch and escapement that would result from implementation of Alternatives 2 and 3 relative to Alternative 1. Under Alternative 2 in Southeast Alaska, NMFS estimated that the mortality rate of listed fish would be reduced by 2.6 and 1.8 percent for Baselines 1 and 2, respectively. It was assumed that the harvest rate in the Canadian fisheries would not change. In the Pacific Coast and Columbia River basin fisheries, it was assumed that selective fisheries would be fully and successfully implemented and that the fish encountered under Alternative 1 would be subject to a 31 and 10 percent handling mortality, respectively. Some of the resulting savings would be lost during subsequent upstream passage, with the remainder passed to escapement. Under Alternative 3, it was assumed that harvest mortality in each of the jurisdictions would be reduced to zero with all fish distributed to either Canadian fisheries, dam mortality, or escapement.

This analysis is simplified and does not attempt to take into account the feasibility of the proposed alternatives, complications related to expected mortality rates under the alternatives, how the Canadians might respond to changing circumstances, or how the stock would respond in subsequent years as a result of increased escapement in previous years.

The numbers themselves, therefore, have little meaning outside the context of this analysis and should not be otherwise used or taken out of context. The point of the analysis is to represent the flow of fish from the ocean, through the fisheries, and ultimately to escapement, as well as the cumulative effect of the proposed alternatives. Some of the fish foregone in one fishery will be lost to other fisheries or dam mortality, but the remainder will contribute to escapement.

Alternative 2 assumes that NMFS can fully and successfully implement selective fisheries for chinook in the Pacific Coast and Columbia River fisheries. Potential problems related to the feasibility of implementing selective fisheries for chinook are discussed elsewhere; however, if the related problems can be resolved and selective fisheries can be implemented as described under Alternative 2, the retrospective analysis suggests that escapements would have increased by 135 and 39 percent in the respective baselines. If the incidental take of listed Snake River fall chinook is eliminated subject to Alternative 3, escapements would have increased by 182 and 53 percent for Baselines 1 and 2, respectively (Table 4.5-4). Because the presumed exploitation rates for Baseline 2 were lower and the escapements were higher, harvest reductions resulted in a smaller proportional change in escapement.

Table 4.5-4. Approximate cumulative effects of Alternatives 1, 2, and 3 on Snake River fall chinook.

Year	Run Size	Southeast Alaska	British Columbia	Pacific Coast	Columbia River Harvest	Dam Related Mortality	Spawning Escapement
Number of Snake River Fall Chinook in Adult Equivalents ages 3+							
Alternative 1							
Baseline 1	4,411	187	1,191	816	1,094	736	388
Baseline 2	2,132	101	326	134	400	623	548
Alternative 2							
Baseline 1	4,411	182	1,192	253	137	1,733	913
Baseline 2	2,132	99	326	42	42	863	759
Alternative 3							
Baseline 1	4,411	0	1,243	0	0	2,075	1,093
Baseline 2	2,132	0	342	0	0	952	837
Percent change relative to Alternative 1							
Alternative 2							
Baseline 1	0	(3*)	0	(69*)	(87*)	135	135
Baseline 2	0	(2*)	0	(69*)	(89*)	39	39
Alternative 3							
Baseline 1	0	(100*)	4	(100*)	(100*)	182	182
Baseline 2	0	(100*)	5	(100*)	(100*)	53	53
Mortality as percent of total run							
Alternative 1							
Baseline 1	100	4	27	18	25	17	9
Baseline 2	100	5	15	6	19	29	26
Alternative 2							
Baseline 1	100	4	27	6	3	39	21
Baseline 2	100	5	15	2	2	40	36
Alternative 3							
Baseline 1	100	0	28	0	0	47	25
Baseline 2	100	0	16	0	0	45	39

Notes: Observed estimates are chinook mortalities in adult equivalents (Sands and Koenings 1997). Estimates for Alternatives 1 and 2 are based on observed harvest rates in each region multiplied by harvest-adjusted levels of abundance entering the fishery.
Incidental mortality assumed to be 31 percent in Pacific Coast fisheries and 10 percent in Columbia River basin fisheries. Canadian harvests not adjusted for 1999 PST harvest levels.
* Percent change represents a decrease in adult equivalents ages 3+.

4.5.2.4 Puget Sound Chinook

Puget Sound chinook are a diverse ESU consisting of approximately 20 distinct populations. The distribution of most of these populations, and thus the rates of harvest to which they are subject, are similar but not identical. By recognizing these differences between populations NMFS can characterize the general level of effect in the fishing areas under the proposed alternatives. The observed total exploitation rates in all fisheries from 1988 to 1993 and from 1994 to 1997 were 74 and 60 percent, respectively; Puget Sound populations are harvested primarily in Puget Sound and Canadian fisheries. The expected exploitation rate in the Southeast Alaska fishery under Alternative 1 was 0.4 percent for Baselines 1 and 2. Harvest effects would not change perceptibly under Alternatives 2 or 3 (Table 4.2-2).

Exploitation rates on Puget Sound chinook in Council-managed fisheries ranged from 2 to 3 percent under Alternative 1 and from 1 to 5 percent under Alternative 2 (Table 4.3-7).

Puget Sound chinook are not affected in Columbia River fisheries. Because of the relatively limited harvest effects on the fisheries considered in this FPEIS, Puget Sound populations would not benefit substantially under any proposed alternative. Greater potential exists to increase escapement of naturally spawning fish through management actions taken in Puget Sound and British Columbia fisheries, which have been addressed through recent ESA reviews.

4.5.2.5 Steelhead, Sockeye Salmon, and Chum Salmon ESUs

Five steelhead ESUs from the Columbia River basin are listed as either threatened or endangered; however ocean fishing effects are believed to be extremely rare. Therefore, effects from the proposed alternatives on these stocks would be limited to those in Columbia River fisheries.

McClure et al. (2000) concluded that population growth rates for Lower Columbia River and Upper Columbia River ESUs could be stabilized under a no harvest management scenario; however, for Upper Willamette River, Middle Columbia River, and Snake River steelhead ESUs, a complete cessation of harvest would be insufficient, absent other beneficial actions, to provide reasonable certainty of recovery. Recovery for all of the steelhead ESUs will therefore require substantive actions to improve survival during other phases of the species' life history.

It is pertinent to point out that selective fishery management measures consistent with Alternative 2 have been implemented, in some cases, with resulting decreases in harvest mortality to natural-origin fish. Hatchery steelhead in the Columbia River basin have all been fin clipped since the mid-80s. Retention of steelhead in non-Tribal commercial fisheries is prohibited but Tribal commercial fisheries are managed with time, area, and gear-type restrictions to limit effects. Non-Tribal recreational fisheries require the release of unmarked steelhead. Alternative 2 has, therefore, been largely implemented for steelhead in non-Tribal fisheries in the Columbia River basin.

Tribal fisheries occur primarily in Zone 6 and the tributaries above Bonneville Dam; therefore, they have little effect on the Willamette River steelhead ESU and relatively little effect on the Lower Columbia River ESU, which is located primarily below Bonneville Dam. The harvest of steelhead in Tribal fisheries occurs mainly during the fall season. In the past, fall season fisheries targeted both fall chinook and steelhead; however, since the steelhead listings, efforts have been made to reduce the incidental effects on steelhead. The harvest rate on Snake River B-run steelhead has been limited in recent ESA consultations to 15 percent in the Tribes' fall season fishery compared to a 32 percent harvest rate limit allowed before listing. The harvest rates on summer A-run stocks returning to the Snake River, Upper Columbia River, and Middle Columbia River ESUs are generally 10 percent or less in the Tribal fishery and 2 percent or less in non-Tribal fisheries. The Tribes have reduced steelhead effects in recent years through voluntary efforts to avoid times and areas of concentration and by encouraging the use of larger mesh gillnets. Additional management measures could be taken to further reduce steelhead effects including regulating the use of larger mesh or other selective gear types and requiring the release of unmarked steelhead in the platform fishery. Most of the remaining harvest of steelhead occurs in the Tribes' traditional set gillnet fishery. Additional savings could be made in this fishery, but would require using different gear or changing to live capture techniques that permit the release of unmarked fish; this would require more fundamental changes in current fishing methods.

Sockeye salmon from the Snake River and Upper Columbia River are subject to little harvest in ocean fisheries; therefore, the cumulative effects of the proposed alternatives are limited to those in the Columbia River basin. Sockeye are taken in the mainstem fisheries in the Columbia River although harvest rates have been limited in recent years from 6 to 8 percent by ESA constraints to provide necessary protection for listed sockeye returning to the Snake River. From 1988 to 2000, there were no fisheries directed at sockeye, which mainly come from unlisted populations returning to the Upper Columbia River because of the depressed status of all of the stocks. Higher returns of Upper Columbia River stocks, and some limited fisheries directed at sockeye occurred in 2000 and 2001 although they were subject to the consultation limits. If the run size exceeds the escapement goal, implementation of Alternative 2 would emphasize the use of terminal area fisheries directed at the Upper Columbia River populations. Implementation of live capture, selective fisheries provides the opportunity to release sockeye in mainstem fishing areas below the confluence with the Snake River, which may help provide access to other species if sockeye are limiting. There is, however, little opportunity to implement a mass mark-selective fishery for sockeye that would provide greater access to unlisted sockeye in mixed-stock fishing areas because most of the production is from natural-origin fish, which are not marked.

Similarly, chum salmon from the Lower Columbia River chum ESU are subject to little ocean harvest. Because Lower Columbia River chum reside below Bonneville Dam, they are also not subject to Tribal fisheries in Zone 6. Harvest rates in the lower river fishery are generally 2 percent per year because of the later timing of their return and because there are no fisheries that target chum. Implementation of live-capture fisheries would permit the release of chum that are taken in the lower river fishery, although the benefits would be relatively limited because of the already low harvest rates. There is no opportunity at this time for mark-selective fisheries targeted at chum because the only hatchery production of chum is geared to recovery efforts. As a result, there would be little difference between Alternatives 1 and 2 for chum salmon; Alternative 3 would provide little additional benefit to the species.

4.5.2.6 Effects on Other ESUs or Stock Groups

Central Valley Fall Chinook ESU

Central Valley fall chinook are the primary contributors to ocean fisheries off California and account for 80 to 90 percent of the chinook harvested in Council-managed fisheries. Ocean harvest rates on the Central Valley stocks (expressed using the Central Valley Index) have ranged from 54 to 79 percent (Council 2001a) since 1970. This stock is managed using an escapement range (goal) of 122,000 to 180,000. Escapements were below this goal from 1990 to 1994, but met the goal in years before 1990; escapements have exceeded the range each year since 1994.

For the purposes of analysis in this FPEIS, status quo harvest rates (under Alternative 1) were presumed to be 73 percent for both Baselines 1 and 2. Under Alternatives 2 and 3, harvest rates would be reduced to 23 to 27 percent (Table 4.3-7) and zero percent, respectively. The resulting additional contribution to escapement under Alternative 2 would depend on subsequent inriver harvest and mortality, but would likely be substantial. In general, the management objectives for Central Valley fall chinook have been met in most years. Implementation of Alternatives 2 or 3 would provide greater certainty of meeting the current objectives but would generally lead to escapements that were substantially greater than the escapement range.

Klamath River Chinook ESU

Ocean harvest rates on Klamath River fall chinook (expressed as a fraction of the age-4 ocean abundance) ranged from 44 to 61 percent from 1986 to 1990, and has ranged from 4 to 21 percent averaging 12.5 percent, since then (Council 2001b). Most fishery effects on this ESU are in Council-managed fisheries off California and southern Oregon and in inriver fisheries. Although NMFS determined this stock does not warrant listing, the stock serves as the primary constraint on ocean salmon fisheries in most years for the KMZ and adjacent fishing areas. This harvest constraint is caused, in part, by the obligation to share harvest of this run with recreational and Tribal fishers in the Klamath River. Harvest rates of 6 to 7 percent under Alternative 1 would be reduced to 2 to 3 percent under Alternative 2 (Table 4.3-7). Because recreational and Tribal fisheries in the Klamath River are not subject to the federal action considered in this FPEIS, it is difficult to determine the degree to which increased escapement benefits from the ocean fisheries under Alternative 2 or 3 would accrue to spawning escapement.

The escapement of natural origin fish to the Klamath River has been variable in recent years, ranging from 12,000 to 162,000 since 1988 (Council 2001b). This stock is currently managed using an escapement rate objective of 33 to 34 percent with an escapement floor of 35,000. This management strategy has been successful in providing a wide range of escapements that will contribute to the ability to better evaluate the productivity of the system, but has not always been successful in keeping escapements above the escapement floor. Since 1988 escapements have been below the floor six times. Implementation of Alternative 2 or 3 may contribute additional fish to escapement, depending on how the subsequent inriver fisheries are managed; however, because harvest rates have been sufficiently low in recent years, further reductions would not guarantee an escapement rate of 35,000 during low-run years.

Oregon Coastal Chinook ESU

Brood year ocean exploitation rates for this ESU ranged from approximately 25 to 50 percent during the 1980s and 1990s. Approximately 28 percent of the harvest-related mortality occurs in the Southeast Alaska fishery, with a similar proportion occurring in Canadian fisheries (CTC 2001). This ESU is subject to very little harvest in Council-managed fisheries and is not affected by Columbia River basin fisheries. Exploitation rates were assumed to be 1 percent or less under Alternative 1 in Council-managed areas (Table 4.3-5). In general, these stocks are considered to be healthy, and most stocks meet their respective escapement goals in most years (CTC 2001). Implementation of Alternative 2 or 3 would have a minor effect on overall escapement; thus, for reasons of conservation, neither alternative is considered necessary.

Washington Coastal Chinook ESU

Total brood year exploitation rates on this ESU averaged approximately 60 percent during the 1980s and 1990s. Approximately 15 percent of the harvest-related mortality occurred in the Southeast Alaska fishery, but effects in Canadian fisheries are somewhat higher (CTC 2001). This ESU is subject to little harvest in Council-managed fisheries and is not affected by fisheries in the Columbia River basin. In general, chinook stocks from the Washington coastal area are healthy and the majority of stocks meet or exceed their escapement goals in most years (Council 2001a). Implementation of Alternative 2 or 3 would have a minor effect on overall escapement and thus, for reasons of conservation, neither alternative is considered necessary.

Olympic Peninsula and Puget Sound Coho ESUs

Wild spawning fish are thought to make up approximately 30 percent of these two ESUs, combined. Harvest rates on both ESUs in Council-managed areas have been less than 10 percent in recent years. The largest effects on the Puget Sound stocks occur in British Columbia and Puget Sound fisheries. Although Alternative 2 could decrease harvest effects on these two stock groups in Council-managed areas (particularly using a biologically conservative approach such as Option A), the benefit of this decrease to spawning escapement would be significantly affected by actions in the Canadian and Puget Sound fisheries.

4.5.3 Summary of Cumulative Harvest Effects

The status of salmonid stocks along the Pacific Coast differs, but there are still many healthy natural-origin populations that contribute substantially to existing fisheries (e.g., Upper Columbia River fall chinook and populations of the Washington coastal chinook ESU). Many stocks are depressed, and some are critical, as evidenced by the listing of 26 ESUs; within the listed ESUs, however, healthy populations exist (e.g., Lewis River bright fall chinook).

As in the past and before listing, management actions have been taken to reduce harvest mortality to comply with conservation mandates of each fishery jurisdiction. Since the listings, the effects of Southeast Alaska, Pacific Coast, and Columbia River basin fisheries on listed ESUs have been reconsidered through ESA consultations, and harvest limits were established and incorporated into Alternative 1. In all cases in this FPEIS, NMFS assumed that fisheries would continue to be managed to meet ESA requirements and that those requirements would evolve over time.

Within the overall constraint of ESA compliance, this FPEIS discusses three programmatic alternatives for each of the three management jurisdictions as follows:

- Alternative 1, No Action, characterizes management practices contained in recent consultations.
- Alternative 2, Live Capture, Selective, and Terminal Fisheries, considers alternative management strategies that were designed to reduce effects to natural-origin fish through a variety of selective harvest methods.
- Alternative 3, No Incidental Take, defines the end point of a conceptual continuum of increasingly restrictive practices.

For Alternative 3, NMFS assumed that fisheries would be managed under the requirement that no listed salmonid species would be caught.

The sequence of proposed alternatives from Alternative 1 to Alternative 2 to Alternative 3 involves decreasing levels of harvest effects on listed fish. In general, harvest reductions will lead to increased escapement; however, the magnitude of that increase, and thus the cumulative effect, depends on the following:

- The magnitude of the existing harvest
- The distribution of each stock relative to each fishery
- The potential for intervening mortality that may occur between the affected fishery and the spawning grounds

For some stocks, the harvest rate under status quo management (Alternative 1) is already low and leaves little opportunity to contribute further to necessary survival improvements. The analysis of McClure et al. (2000) indicated that this was the case for many ESUs in the Columbia River basin, including Upper Columbia River spring chinook, Snake River spring summer chinook, and several of the steelhead ESUs. For other ESUs such as Snake River fall chinook, Upper Willamette chinook, and Lower Columbia River chinook, past harvest rates were high enough so that harvest reductions would be sufficient to address estimates of necessary survival improvements. Whether it is sufficient or appropriate to look to harvest alone to address the conservation problem is a subject to be resolved through the recovery planning process. For some ESUs, it is apparent that harvest reductions, combined with remedial action in other sectors, have contributed to encouraging trends of increased escapement (e.g., Sacramento winter run chinook and Upper Willamette River chinook).

The distribution of stocks, relative to the fisheries under consideration in this FPEIS, also is an important determinant of cumulative effects (e.g., some stocks have a very broad distribution and will benefit from harvest reductions in the ocean and inriver fisheries). Snake River fall chinook provide an example of a stock affected by fisheries in Southeast Alaska, the Pacific Coast, and the Columbia River basin; most stocks, however, have more limited distributions. Chinook and coho stocks from California and Oregon are largely unaffected by fisheries in Alaska or the Columbia River basin. Steelhead and many of the spring chinook stocks are unaffected by ocean fisheries. As a result, the cumulative effects or interactions between fishery jurisdictions are stock specific, and the interactions between jurisdictions are quite limited for many of the stocks.

Harvest reductions as a result of the proposed alternatives will enhance escapement, but intervening sources of mortality will also affect escapement rates. Fish saved in one fishery may die of natural causes before escapement, must pass through any subsequent fisheries, and are also subject to subsequent human-induced mortality that may occur during upstream passage. For example, Snake River fall chinook may be saved from harvest actions taken in Southeast Alaska, but will be subject to harvest in Canadian, Pacific Coast, and Columbia River basin fisheries, as well as to an inter-dam loss rate of 50 or 60 percent. In general, fish saved as a result of harvest reductions are still subject to intervening losses so that a portion will ultimately pass to escapement; nonetheless, lower harvest rates do translate into more escapement.

Implementation of the proposed alternatives would regulate harvest to affect escapement; however, increasing escapement will not necessarily result in recovery. In general, salmonid populations must be productive enough so that each adult spawner will replace itself in the subsequent generation. For many, if not most listed stocks, habitat degradation has reduced the productivity of populations to a level where they can no longer replace themselves; this leads to long periods of decline. Harvest reductions can compensate for this lost productivity to a point, but they would do little to increase the inherent productivity of the population. This FPEIS focuses on management alternatives related to escapement, but the cumulative effects of all actions affecting the survival of the species must be addressed if the species are to recover.

4.5.4 Cumulative Effects on other Aspects of the Biota

Adopting either Alternative 2 or Alternative 3 would increase the number of salmon escaping to streams and hatcheries. Nutrient levels would be enhanced from carcass deposition leading, perhaps, to incremental change in the biota. Increased spawning production would lead to an enhanced food base for predators of juvenile salmonids such as birds, northern pike minnows, and trout; however, it would also increase the number of salmon predating on other life forms, notably insects. Implementing Alternative 3 in all three jurisdictions, with a simultaneous reduction in hatchery production, would decrease competition between hatchery and natural stocks for food and shelter in riparian, estuarine, and marine areas; and could cause, at a minimum, a temporary reduction in the amount of prey available to predators in freshwater and marine environments because a majority of the production in some areas is currently from hatcheries.

Salmon fisheries in each of the management areas are classified as Category III fisheries under the Marine Mammal Protection Act, indicating that impacts to marine mammals from the fisheries are negligible. Because Alternative 2 generally proposes no changes in fishing method or gear, except perhaps in the Columbia River, effects of fishing activity to marine mammals relative to Alternative 1 would be essentially nonexistent. In the Columbia River, gear changes associated with Alternative 2 would likely reduce the limited interactions that do occur. Effects under Alternative 3 in all areas would include a decrease in fishery-related interactions, to the degree that they occur; localized, short-term increases in availability of salmon to predators; and an increase in predation on salmon prey species caused by the decline in harvest.

Review of the anticipated direct effects to avian species from salmon fishing in each area suggest that the effects are quite limited. Because direct effects are minimal, changes under Alternative 2 or Alternative 3 would likely be unmeasurable. Alternatives 2 and 3 would theoretically lead to an increase in escapement of hatchery and naturally spawning salmon. Higher escapements in natural-production areas would increase food available to birds that consume salmon carcasses and the subsequent progeny of the spawning salmon.

4.5.5 Related Issues

4.5.5.1 Hatchery Production

An important cumulative benefit of Alternative 2 is the potential to provide a respite from harvest for wild stocks, which should complement habitat-related actions. Alternative 3 would reduce effects on these stocks further.

There is a growing concern regarding the role hatcheries have played in the decline of wild stocks, which has resulted in a broad reevaluation of hatchery management policy for all jurisdictions addressed in this FPEIS. Salmon and steelhead fisheries in Council management areas and the Columbia River basin, and to a lesser extent Southeast Alaska, are dependent on hatchery production. Implementation of Alternative 3 for the Pacific Coast or Columbia River basin without reducing or curtailing hatchery production would increase hatchery straying and possibly lead to more genetic introgression and more competition with wild stocks for resources. Under Alternative 3, however, there would be little reason to maintain the operation of hatcheries and, thus, wild/hatchery fish interactions would likely be a short-term phenomenon.

Absent hatchery production, there would be extremely limited opportunities for recreational, commercial, or ceremonial and subsistence fishing in California, Oregon, or Washington in the foreseeable future. Ceasing hatchery programs that were designed (in part) to mitigate losses of natural runs for Pacific Northwest Tribes may constitute serious breaches of federal court mandates, treaties, and other agreements.

4.5.5.2 British Columbia Fisheries

Because a large percentage of Puget Sound and Columbia River chinook and considerable numbers of chinook from Oregon streams are taken in British Columbia, conduct of Canadian fisheries is highly important to the federal action considered in the FPEIS. Provisions of the revised Pacific Salmon Treaty are strategically important for reducing harvest effects on listed chinook ESUs and their continued implementation is viewed as critical.[13]

4.5.5.3 Mass Marking

Mass marking of chinook and coho salmon may affect current management schemes for salmon because it requires changing methods for gathering and interpreting data from coded-wire-tags (CWTs), the primary tool used by fishery management agencies for evaluating changes in salmon production, distribution, and exploitation. For the past three decades, managers have accumulated data on the distribution and exploitation of both hatchery and wild stocks from the CWTs implanted in hatchery-reared fish. Fish with these tags are marked by clipping the adipose fin so that they may be distinguished by fishermen, fishery samplers, and hatchery managers. This ability to visually recognize marked fish has been key to the CWT sampling program. Because selective fishery effects on hatchery

[13] From 1997 to the present, harvest management in British Columbia has been more restrictive than required under the revised Annex 4, allowing additional listed and unlisted salmon to return to southern fisheries and streams. This additional escapement has figured significantly in meeting Council conservation objectives for several stocks.

(marked) and wild (unmarked) salmon would be different, marked/CWT fish would no longer be representative of the unmarked fish.

Because clipping the adipose fin was determined to be the most feasible means of mass marking, comprehensive mass-mark programs require an alternate system for gathering CWTs from fisheries. Initial mark-selective coho fisheries were monitored using a double index tagging/random sampling protocol. One-half of the hatchery fish implanted with CWTs are marked by adipose clipping but the other half are not fin clipped; catches are then randomly sampled using electronic detectors to retrieve fish with CWTs. The double index tagging system is designed to help reconcile historical and contemporary data so that management models for coho will not be significantly compromised.

The double index tagging system has not been completely assessed; therefore, it is not known how well the system will work for chinook salmon. Unlike coho, chinook salmon mature over several years in the ocean and individual unmarked chinook may be encountered and re-encountered in selective fisheries for 2 to 5 years, which complicates estimation procedures of fishing mortality for a given brood year. The Selective Fishery Evaluation Committee of the Pacific Salmon Commission, which is charged with evaluating the system, has been unable to develop a means of allocating incidental mortalities to individual selective fisheries when multiple selective fisheries affect a stock, nor has it concluded whether the viability of the CWT system for chinook can be preserved under mass marking and selective fisheries. The committee has noted, however, that alternative methods are under investigation and preliminary indications are sufficiently promising to warrant further research (PSC 1999c). Maintaining the viability of the CWT system is paramount, and thus requires that solutions be found before selective fisheries are implemented.

Other limitations of mass marking and the CWT system have been identified but excluded as significant problems; most problems associated with mechanically mass-marking young-of-the-year chinook salmon have been overcome. Studies indicate electronic tag detection is adequate, although the Selective Fishery Evaluation Committee cautions that tag detection capabilities for chinook salmon have not been tested under fully operational conditions. Concerns have been raised regarding the availability of tag detection equipment throughout the range of selective fisheries; additionally, the CWT management system for chinook salmon could be compromised during the transition period when selective fisheries harvest a mixture of mass-marked and previously unmarked chinook salmon.

A potentially important benefit of mass marking is that it provides a simple means to distinguish between naturally spawning (unmarked) fish and hatchery fish, both in the fisheries and on the spawning grounds. NMFS status reviews for many chinook, steelhead, and coho ESUs highlight the difficulty in assessing the viability of natural runs in watersheds because of the uncertainty about the proportion of hatchery fish co-mingled with the wild run. Although the CWTs in hatchery surrogates for various wild stocks provide managers with approximations of the ocean distribution of wild stocks among the fisheries and the associated harvest rates, it has not been possible to directly observe the proportion of wild fish present in various fishing areas or, specifically, on the spawning grounds. This information is key to assessing the status and productivity of natural-origin populations, and as a result, a greater proportion of hatchery-origin fish will likely be marked in the future for stock assessment purposes. Complications related to the viability of the CWT management system relate primarily to the implementation of selective fisheries rather than the mass marking itself. The ability to implement selective fisheries that target the mass-marked fish will, therefore, be an added benefit of the program if the associated technical problems can be resolved.

4.6 Economic and Social Implications of Recovery

This assessment addresses the potential economic and social benefits of recovery and how the proposed alternatives would contribute to achieving these benefits. This assessment builds upon the previous discussion of cumulative biological effects.

In general, the economic benefits of recovery can be classified as related to use and non-use values. Use values include the economic and social benefits associated with commercial and recreation fishing, both inriver and in the ocean. Key economic indicators of use values include gross revenues, employment levels, and income levels generated both directly and indirectly by fishing activity. Non-use values, which are often referred to as passive use values, are benefits not related to people's use of the resource and include existence value (people's WTP to know that fishery resources exist, although they have no plans to use them), and bequest value (WTP to know that future generations will be able to enjoy the resource). As identified by Huppert and Fluharty (1995), other social benefits of recovery include spiritual and cultural values that are held by certain members of society, such as Tribal members. These values transcend monetary valuation because the people who hold these values do not believe that these values can be accurately translated into monetary terms.

Estimating the economic and social benefits of recovery is difficult for several reasons, including the lack of consensus on what constitutes recovery of protected species or when it can be achieved. In the ESA recovery is defined as "improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the [Endangered Species] Act," but for purposes of this assessment, recovery is defined as "returning natural populations to self-sustaining levels." In terms of use values, the concept of self-sustaining levels can be interpreted as meaning the return to predictable and consistent harvest by recreation and commercial fishing interests. Moving toward recovery would result in benefits both to users of the resource and to non-users. The magnitude of these benefits, however, is difficult to estimate because of the uncertainty about when and how the resource would recover. The path to recovery would include increased escapement to spawning grounds, which, in turn, could be expected to result in the relaxing of existing harvest restrictions, expediting recovery, or some combination of both outcomes. Easing harvest restrictions not only would allow for greater harvest of protected species but, even more importantly and from a harvest perspective, would likely allow greater utilization of unlisted stocks.

One recent study (USFWS 1999) on the economic benefits of restoring salmon populations on the Trinity River in Northern California found that easing ocean restrictions on salmon harvest (as a result of listings) would generate an additional $7.7 million in ex-vessel value to commercial fishers in California and Oregon. Of this value, only $630,000 was directly attributable to harvesting additional stocks of Trinity River naturals, with the remaining $7.1 million of value attributable to the easing of harvest restrictions on other stocks. Most of the increased value was estimated for harvest management regions north and south of the KMZ. The study also found that easing harvest restrictions would generate approximately $6.1 million in additional benefits to recreational anglers in California and Oregon.

The economic and social benefits of recovery also can be evaluated from a historical perspective (i.e., what value did healthy, pre-listed fisheries produce for recreation and commercial fishers historically). As shown in Table 4.6-1, sport-fishing activity at port areas along the West Coast

Table 4.6-1. Historical economic indicators for pre-listed sport and commercial salmon fisheries on the Pacific Coast.

Port Area	Sport fishing Angler Trips for Salmon		Commercial Salmon Landings (thousands of pounds)		Local PI Generated by Salmon Fisheries, 1976-1980 Average	
	1976-80 Average	Highest Year[a]	1976-80 Average	Highest Year[a]	Sport	Commercial
Neah Bay	44,200	59,100	888	1,508	1,754	4,383
La Push	24,700	46,100	1,207	2,602	1,531	6,610
Grays Harbor	210,300	263,200	1,985	3,645	12,291	14,581
Columbia River	211,300[b]	301,300[b]	1,495	2,924	7,716	8,042
Tillamook	43,800	56,300	778	1,540	2,172	4,314
Newport	97,700	131,800	1,720	2,668	4,040	10,114
Coos Bay	111,100	154,000	2.569	5,060	5,341	15,565
Brookings	74,400	93,900	1,057	1,319	3,520	6,469
Crescent City	20,000	28,700	753	1,121	988	5,354
Eureka	23,900	30,500	1,794	2,115	1,146	13,529
Fort Bragg	11,700	17,000	1,726	2,469	667	13,218
San Francisco	97,900	106,200	1,842	2,234	10,030	17,345
Monterey	10,000	14,200	937	1,245	672	7,536
Total	**981,000**	**N/A**	**18,751**	**N/A**	**51,868**	**127,060**

Notes: Personal income figures are expressed in 1996 dollars and thousands.
a/ Represents the years with the greatest number of angler trips and commercial landings between 1976 and 1980
b/ Includes Astoria, Warrenton, Hammond, Ilwaco, Long Beach, Nahcota, Naselle, and all Columbia River basin ports.
N/A = not applicable
PI = personal income
Source: Council 1993, 1997.

averaged approximately 981,000 trips annually between 1976 and 1980 compared to approximately 246,000 trips under status quo conditions for Baseline 1 (1988-1993). As for commercial fishing, landings at West Coast ports averaged approximately 18.7 million pounds between 1976 and 1980 compared to approximately 644,300 pounds for Baseline 1. Although returning to the sport and commercial harvest levels of the late 1970s is unlikely given that overharvesting is one of the factors that has led to species decline and the need for listing, historical levels do provide a useful yardstick for assessing potential economic benefits of recovery to commercial and recreational fisheries.

Based on several recent studies, non-use values associated with salmon recovery are likely substantial. One study (Olson et al. 1991) estimated that residents of Pacific Northwest households, which had no probability of using Columbia River salmon resources in the future, were willing to pay an average of $26.50 annually (1991 dollars) for a doubling of Columbia River salmon runs. Extrapolating these values to non-users in the region, as a whole, results in an annual WTP of approximately $42.4 million. Other examples of the economic and social value that society places on salmon recovery include recent legislation such as the Central Valley Project Improvement Act and ongoing public expenditures for efforts on the Columbia and Snake rivers to reverse trends in the decline of salmon.

As previously discussed, the proposed alternatives evaluated in this FPEIS would incrementally contribute to the recovery of listed species. Although the potential contribution of harvest management varies considerably by ESU, it is a critical part of an overall strategy that includes changes to habitat, hydropower operations, and hatchery operations.

In summary, recovery of Pacific salmon stocks currently listed under the ESA would provide substantial economic benefits to persons who use the resources, and would generate greater social benefits to persons concerned about the survival of protected species. Increased escapement to rivers where salmon spawn is likely to result in the eventual easing of harvest restrictions, which appears to have a use value to commercial and recreational anglers of more than $13 million annually. In addition, society's WTP to achieve recovery of listed species appears (based on results of other studies) to be more than $40 million annually. The incidence of these benefits over time depends on the success of many factors in rebuilding listed stocks.

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